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EHRLICH'S CHEMOTHERAPY—A NEW SCIENCE[1]

HARDLY at any time in the history of modern medicine has there existed a more intense excitement and a more absorbing interest among the medical fraternity than at present. One of the greatest scourges of humanity—perhaps the most insidious and cruel of all, since it so often places its victims beyond the pale of human sympathy, to be loathed rather than pitied—is on the point of being eradicated. So abhorrent is the disease in the public mind that the press of the United States, which chronicled at great length the daily events in the life of Evelyn and Harry Thaw, feels constrained not to offend its readers by mentioning its name "syphilis," but hypocritically refers to it as a "blood disease."

The man to whom humanity is indebted for this achievement is Professor Ehrlich, of Frankfort-on-the-Main. This scientist is no stranger to chemists. As far back as thirty years ago Ehrlich employed organic substances, mainly coal tar colors, in his physiological studies. He discovered that methylenblue and its congeners were the only colors which stained the live nerve tissue, and in order to determine whether this remarkable property was due to the peculiar constitution of methylenblue or to the presence of the sulfur in it, he desired to experiment with an analogous substance in which the sulfur, however, was replaced by oxygen. He applied to Dr. Caro, who, alas for our science,

[1] Read before the New England Section of Society of Chemical Industry, Boston, October 7, 1910.

died last October, requesting him to assist in this work by furnishing the material necessary for the experiments. As the desired substance was then unknown, it was proposed to synthetize it by allowing nitrosodimethylanilin to react on metaoxydimethylanilin. This latter body being likewise unknown had to be prepared. Naturally the chemical thus originated was employed not only for the purpose suggested by Ehrlich, but also for all reactions for which analogous products had been previously used. One of the first experiments made was to try it in place of resorcin, to which it is closely related. The principal use of resorcin in the color industry was the manufacture of fluorescein by fusing it with phthalic acid anhydride. From fluorescein was made eosin, a particularly fine coloring matter. The Ehrlich product, however, gave in the same reaction a color even superior to eosin, namely, rhodamine, and in another reaction it furnished Nileblue.

Although originally a physician, Ehrlich, through steady pursuit of our science, developed into a most proficient and ingenious chemist, and by combining physiological with synthetic chemistry he created on their borderland the new science of chemotherapy.

To demonstrate to you the nature of chemotherapy, it is perhaps best to show what has hitherto been accomplished by Ehrlich and his school.

In the development of bacteriology, the science upon which are based the most important advances of modern medicine, the coal tar colors have played an indispensable part. These dyestuffs made possible the discovery of the dreaded microbes and their detection in disease. It was found that different bacteria manifested a selective affinity for different colors, some absorbing one and some the other, and this in itself now enables the scientist to distinguish between organisms belonging to the same group.

We know now that many, if not most, diseases are of parasitic origin, and that man and other animals are constantly at the mercy of these invisible enemies. Though attention has been devoted chiefly to the bacteria which belong to the lowest forms of vegetable life, modern research has brought to light the fact that certain diseases are due to protozoa or animalcules, which, on the other hand, constitute the lowest stage of animal existence. Among these disease-producing protozoa the most important that have thus far been discovered are the plasmodium, which causes malaria, the trypanosoma, a parasite which produces the African sleeping sickness, the ameba of dysentery, and the spirochete, the causative agent of syphilis.

It is a curious circumstance that although protozoa were discovered in the blood of various animals as far back as sixty years ago, that is even before the birth of bacteriology, it is only within the last ten years that their important rôle in the causation of disease has been appreciated. A number of causes have contributed to this, especially the fact that most of the maladies due to protozoal parasites occur in tropical countries, while bacterial diseases are constantly in our midst. The discovery of the malarial protozoa, the plasmodium, by Laveran, however, gave an impetus to this line of research, and this circumstance in connection with the special study that is being devoted to tropical diseases has already contributed materially to our knowledge of the origin of many hitherto obscure maladies.

More important than the discovery of the cause of a disease, however, is its prevention and cure. Fortunately, in the case of malaria empirical observation had

supplied a specific remedy, quinin, long before the discovery of the plasmodium. On the other hand, the study of the life history of this organism and the demonstration of its transmission through the bite of the mosquito, have rendered it possible to devise means for malarial prophylaxis. In the case of syphilis clinical experience during many centuries has demonstrated the value of mercury in controlling the manifestations of this disease, but although vaunted as a specific, this remedy can not be regarded a true curative agent, since it has failed to prevent recurrences from taking place, sometimes even after long periods.

One of the most malignant of this group of protozoal parasites is the trypanosoma, the cause of the dreaded sleeping sickness and of various diseases in horses and cattle, whose ravages, especially in the African colonies of England and Germany, make it one of the worst pests with which mankind is afflicted.

A brief description of these parasites will, perhaps, prove instructive. In the first place it must be noted that the trypanosoma has been found in the blood of many animals, both cold- and warm-blooded, and that some varieties of this parasite appear to be perfectly harmless. Those which are of particular interest, because of their virulence, are as follows: (1) *Trypanosoma evansi,* discovered by Evans more than twenty-five years ago, which is the cause of surra, a destructive disease of horses, camels, cattle and dogs prevailing in India as well as in other parts of Asia, and in the Philippines and Africa. (2) *Trypanosoma brucei,* discovered in 1894 by Bruce, which causes the very fatal nagana or tsetse fly disease of Africa in various domestic animals (horses, mules, dogs, cats, etc.), but like the preceding does not attack man. (3) *Trypanosoma equiperdum,* the cause of dourine, a disease affecting horses, but, unlike the above, found outside of tropical countries, particularly on the shores of the Mediterranean. (4) *Trypanosoma equinum,* the cause of mal de caderas, occurring almost entirely among horses in South America. (5) *Trypanosoma Gambiense,* the most important of this group, first shown to be the cause of human trypanosomiasis by Castellani in 1902. (6) Parasite of mbori, a disease of camels in the Sudan, especially in Timbuctoo.

Trypanosomes, while differing more or less in their special characteristics, have in common a worm-like body and are flagellated, that is, provided with a membranous sheath (undulating membrane) terminating in a slender whip-like process designed for locomotion. They are much larger than bacteria and can be seen with a comparatively low power of the microscope swiftly darting between the blood cells, brushing them aside, but not penetrating them like the parasite of malaria, the plasmodium. One of the most remarkable features in their life history is their manner of transmission. While infection with bacteria takes place directly, as through the air, food, water, or through a wound, the trypanosoma, like the parasite of malaria, requires an intermediary or complementary host, usually some blood-sucking insect, as the Indian horse fly or the tsetse fly of Africa. In the act of sucking an infected person or animal the insect draws up the parasite with the blood and carries it about in his proboscis, and later again injects it in biting another individual. While in the case of the plasmodium the parasite undergoes certain changes in the body of the insect, this has not been shown to occur with trypanosome, so that it is commonly believed that the

insect acts chiefly as a carrier of the parasite.

The trypanosome which is of particular interest on account of being the cause of sleeping sickness is the *Trypanosoma Gambiense*. It is disseminated by a species of tsetse fly known as *Glossina palpalis*, which somewhat resembles our common house fly. According to Koch, the *Glossina* subsists largely on the blood of crocodiles, and he recommended that these should be exterminated to reduce the number of insects. It has been shown by others, however, that the tsetse fly disease prevails in regions where there are no crocodiles, and, *vice versa*, that it is not met with in regions where these reptiles are abundant. Probably in the course of time some practical scheme will be devised for exterminating these insects similar to those in vogue in regions infected by the mosquitoes which transmit malaria and yellow fever. The task will be more difficult because the young of the tsetse fly soon reach maturity, as they are born in the larval state instead of being deposited as eggs.

One of the great difficulties in the treatment of sleeping sickness has been that in its early stages the symptoms are so mild that the patients, chiefly ignorant natives, do not resort to medical aid. When seen by the physician, therefore, the disease is generally far advanced, the patient being emaciated, dull, apathetic, dragging along his limbs, but sleeping most of the time, a sleep which finally becomes a coma and terminates in the death of the unfortunate victim.

In the colonization of Africa one of the most important problems is the extermination of this dreaded disease, which is making constant inroads upon the native population, and which in some districts has carried off more than one half of the inhabitants. This increasing prevalence of the disease led the German government to send Professor Koch on a special expedition for its study. Excellent work in this direction has also been done by English scientists, especially the Liverpool School of Tropical Medicine, as well as by the French and Portuguese.

Unfortunately, the treatment of sleeping sickness and of the various trypanosoma diseases has been exceedingly unsatisfactory, but from the work accomplished by various investigators, especially Ehrlich, Laveran, Mesnil and Nicolle, there is sufficient ground for believing that in the coal-tar or the arsenical preparations will be found specific remedies or at least valuable auxiliaries. At any rate, the line of research which Ehrlich has been pursuing in this field demonstrates the superiority of the modern methods of treatment, which are based upon purely scientific deductions and not, as was formerly the case, solely upon empirical observations.

This new system of treatment is founded upon the study of the selective affinity which the various medicaments have for the tissues of the body and for the parasitic organism that may infest it. In the case of most drugs, however, it is difficult and even impossible to understand their selective action, since the changes they produce are for the most part imperceptible. For this reason Ehrlich at an early period of his studies was led to experiment with the anilin colors, since their effect upon those cellular structures for which they have an affinity could be easily determined by their staining property.

In this connection it may be mentioned that as long ago as 1890 Ehrlich, in collaboration with Leppmann, published some observations on the pain-relieving qualities of methylenblue, the correctness of which has since been abundantly confirmed

in practical medicine. In this country A. Jacobi has particularly called attention to this quality of the color and to its value in the treatment of inoperable cases of cancer. Later Ehrlich, in conjunction with Guttmann, experimented with methylenblue in malaria, and found it a true specific for the parasite of the quartan type of the disease, while it acted less promptly or failed in other varieties. In view of the difficulty, however, of experimenting with malarial organisms he found the trypanosoma much better adapted for his studies, since it can be inoculated in small animals, such as mice and rats. Since 1904, with the assistance of K. Shiga, he has tested many hundreds of various colors in order to determine their influence upon trypanosoma infection, and finally found among the benzidin group a color which, when administered to mice inoculated with the trypanosoma of mal de caderas, retarded the progress of the malady for several days. This result, though not decisive, was sufficiently promising to lead him to experiment with other synthetic products of the benzidin group. He finally discovered trypanred, which was found to exert an actual curative effect upon the above-mentioned trypanosoma. When trypanred was injected into mice twenty-four hours after they had been infected with the trypanosoma of mal de caderas, which ordinarily produced death in four to five days, it was noted that on the following day the parasites had disappeared completely from the blood, and the majority of the animals remained permanently cured. Sometimes, however, the parasites reappeared after a number of weeks, and then speedily caused the death of the animal.

These results were confirmed by Laveran and Halberstaedter with other parasites. The former inoculated mice with the parasite of mbori, the latter with the parasite of dourine.

Ehrlich's experiment therefore was the first which clearly showed that it was possible by means of an anilin color to free the body entirely of virulent parasitic organisms. Curiously enough, however, the trypanred which acted so efficiently in this respect in mice inoculated with trypanosoma of mal de caderas, had a much less favorable effect in other species of animals, even the rat, and against other varieties of trypanosoma, as, for instance, that of tsetse disease. On the other hand, Laveran and Franke showed that by combining arsenous acid with trypanred a curative effect could be obtained in conditions unaffected by the latter alone.

In order to improve trypanred, Ehrlich, together with Weinberg, tested a large number of substitution products of this substance, and found among them an amidotrypanred, which acted more efficiently than trypanred itself upon the virulent nagana parasite.

Mesnil and Nicolle, of the Pasteur Institute of Paris, continued Ehrlich's experiments with a large number of synthetic colors. Their first experiments were undertaken with a number of benzidin colors, the parasite selected for the test being the trypanosoma of nagana, the tsetse fly disease. This parasite was chosen because it is more refractory to trypanred than some of the others. These experiments, which were made upon mice, showed that certain blue or violet colors derived from 1.8 amidonaphthol 3.6 disulfo acid, especially the combination with orthotolidin in alkaline liquid, trypanblue acted more efficiently than trypanred. They further found that the azo dyestuff prepared from dichlorbenzidin and the above acid in alkaline combination—a color which produced intense staining of the tissues, and a single

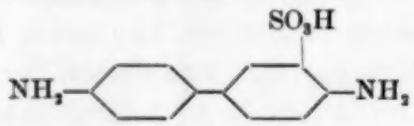
injection of which caused the disappearance of the parasite—was the best agent for the treatment of nagana, mal de caderas and surra. On the other hand, a color derived from paradiaminodiphenyl-urea and the above-mentioned acid acted better than the latter color in the treatment of recurrences of the parasites, although a single injection of it never caused their complete disappearance.

Mesnil and Nicolle then undertook some investigations on monkeys which had been inoculated with the parasite of sleeping sickness, and found that the corresponding color from paradiaminodiphenyl-urea acted best in these cases. They believed, however, that in human beings the conditions for a cure were much more unfavorable, because the patients generally came under observation at a much later period. They also proved that atoxyl was especially useful and recommended the combined use of these substances.

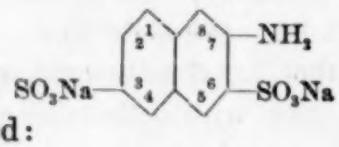
The following structural formulæ will give a picture of the relation of the various classes of colors employed:

Benzidin:

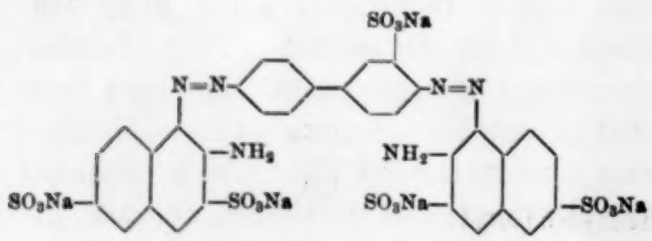
Benzidinmonosulfoacid:



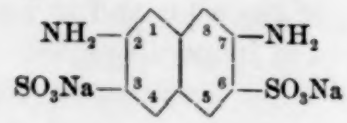
Naphthylamin disulfo acid:



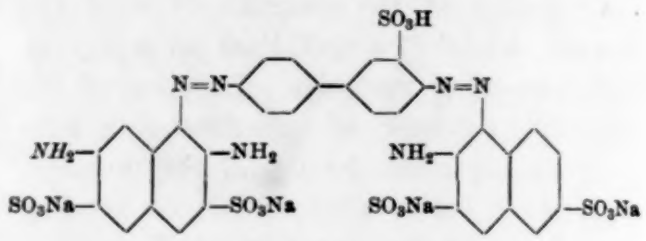
Trypanred:



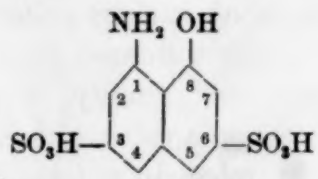
Diamidonaphthalene disulfo acid (2.7.3.6.):



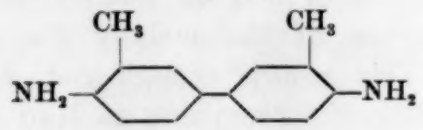
Amidotrypanred (unsymmetrical):



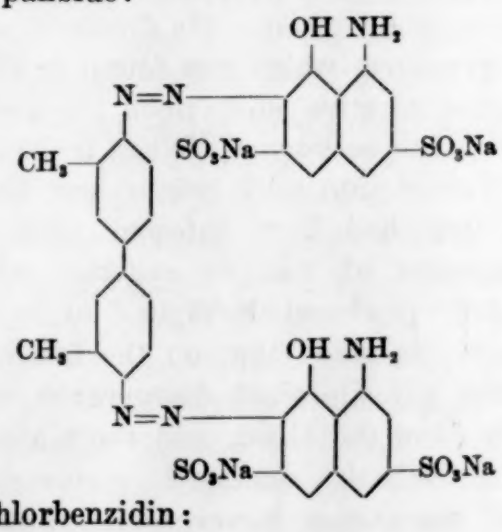
Amidonaphtholdisulfo-acid 1.8.3.6. (called Acid H):



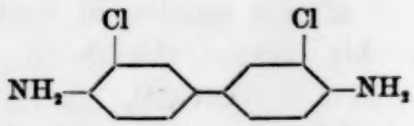
Orthotolidin:



Trypanblue:

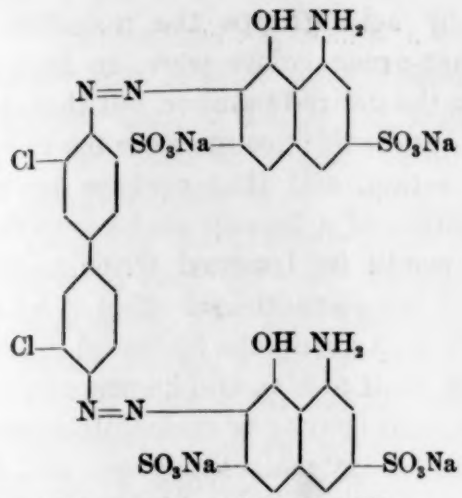


Dichlorbenzidin:

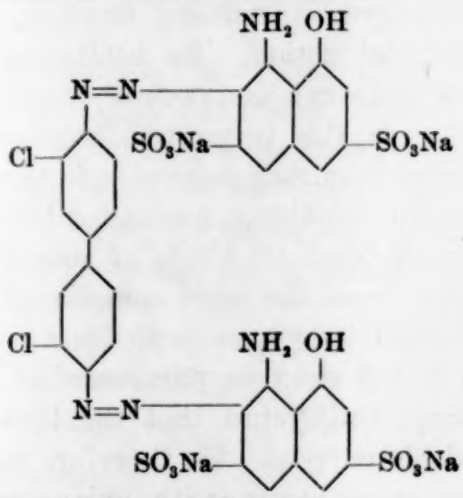


Azodyestuffs with Acid H:

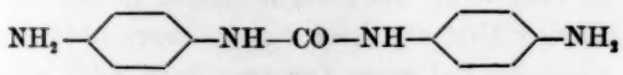
(1) Alkaline combination liquid:



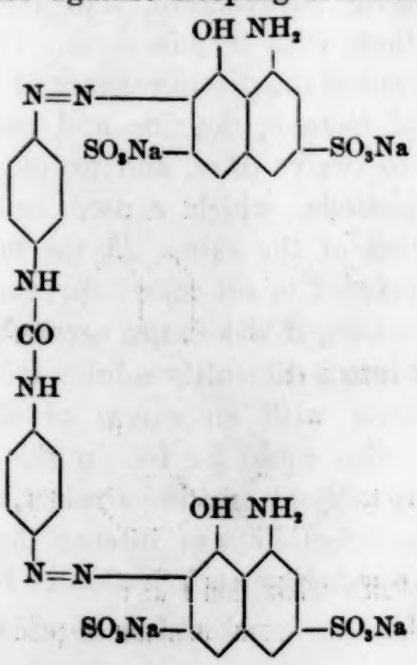
(2) Acid combination liquid:



Paradiamidodiphenyl-urea:



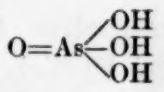
Best color against sleeping sickness:



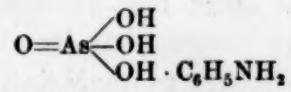
As far as it is possible to draw general conclusions from this mass of material and the results of countless investigations, Ehrlich established the rule that the effective substance must be tetrazo colors derived from naphthalene disulfo acids, with the sulfo groups in the 3.6 position. Mesnil and Nicolle determined that the effective substances must be naphthalene combinations. They must contain at least one amido group and two sulfo groups. Concerning diamines, it was found that dichlorinated substances were the best, and that those amines in which the benzol groups are connected by a two valent group (—NH—CO—NH—) were most active. The most suitable colors were those which dyed the animal body intensely, and it was shown that these were also very good cotton dyes. Altogether, symmetrical colors gave the best results and were less injurious to the health of the animals. Most of the symmetrical colors were absolutely harmless when given in such massive doses as 1 gm. for 15 to 20 gm. body weight of mice.

Concerning the chemistry of atoxyl, it may be mentioned that it is obtained by heating arsenate of anilin and treating the acid solution with alkali.

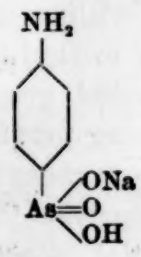
Arsenic Acid:



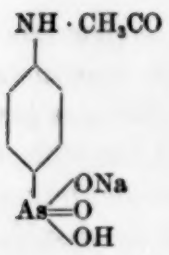
Arsenate of Anilin:



Atoxyl (P. amidophenyl arsinic acid):



Acetyl-Atoxyl:



Atoxyl contains a diazotizable NH_2 group and only one Na. It is possible to prepare azodyestuffs from atoxyl by diazotizing and combining it with the usual amines and acids, and to introduce acyl radicles into the amido group.

To Wendelstaedt belongs the credit of having shown that an entirely different class of colors is capable, even in exceedingly small doses, of causing a temporary disappearance of the trypanosomes, although possessing no definite curative action.

The chief objections to the use of these colors of the malachite- and brilliant-green group are, however, their rather injurious and irritating properties. Various attempts were made to diminish these by experimenting with derivatives of these colors.

Wendelstaedt found, as Ehrlich had previously demonstrated with various groups of chemicals—phenols, alkaloids and dyestuffs—that although sulfo derivatives were devoid of toxicity, they unfortunately lacked any destructive action upon the parasite. When Ehrlich took up experiments with the malachite-green colors he remembered from his previous experience with fuchsin colors, that by alkylation the irritating effect was materially enhanced. He therefore attributed the toxicity of malachite- and brilliant-green to the presence of the four methyl groups in the first and the four ethyl groups in the latter substance. Having previously also demonstrated that the carboxyl groups, like the sulfo groups, deprived these substances of their parasiticidal power, he concluded that by acid groups the malachite- and brilliant-green colors were, in fact, modified in the desired manner, but that the carboxyl- and sulfo-groups were too radical in their action, and that perhaps by the introduction of a faintly acid group the toxicity would be lessened without obliteration of the parasiticidal effect. As such a faintly acid group the hydroxyl group suggested itself to him, and he prepared ortho-, meta- and para-oxy-malachite-green, the di- and tri-oxy-malachite-green, and found, indeed, that they were less toxic than malachite-green, retaining, however, strong parasiticidal action. By combining some of the hydroxyl derivatives of malachite green with the trypanred treatment he succeeded in curing nagana infection when trypanred alone only prolonged life.

Ehrlich tried all kinds of rosanilin derivatives from the most complicated form of ortho-tri-oxy-hexa-methylpararosanilin down to the simplest pararosanilin (parafuchsin), and found that the latter best served his purpose. He therefore made all future experiments with this substance. In reviewing his tests he came to the conclusion that the best results were obtained when he fed mice for two days with cake containing parafuchsin, and then inoculated them with trypanosoma. This treatment caused the disappearance of the parasites of nagana, dourine and caderas for seven to twelve days, and proved superior to injections, which caused considerable irritation of the skin. As the mice, however, refused to eat cake impregnated with parafuchsin, it was found necessary to convert it into a difficultly soluble salt, such as the oleate with an excess of oleic acid. Some mice could be fed in this way for months without any impairment of health. If the infection was intense the feeding was preceded by an injection of fuchsin or atoxyl.

This feeding method seemed also most suitable for human beings, as injections would be too painful, 1 gm. fuchsin base daily being considered a proper initial dose. In giving parafuchsin internally it was suggested that the dose should be as large as possible, and that this treatment might be combined with the administration of atoxyl or some other drug. Ehrlich further proposed feeding with fuchsin as a preventative measure for people traveling through regions where sleeping sickness prevails.

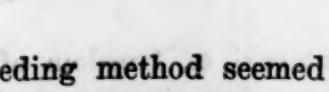
More recently most excellent results were obtained by employing instead of the above parafuchsin, chlorinated parafuchsin, which is known as "tryparosan."

The following formulæ will facilitate a review of the colors experimented upon by Ehrlich:

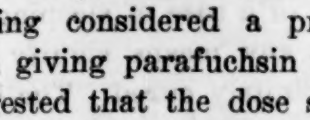
Methylenblue:

Malachitegreen:

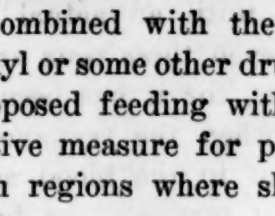
Brilliant-green:



Hexamethylviolet (completely substituted) (Crystalviolet):

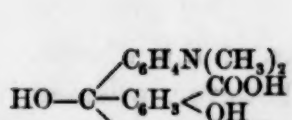


Tritolylrosanilin (New fuchsin):

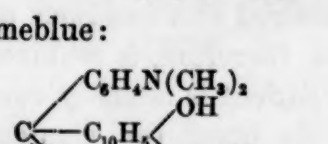


Carboxyl derivatives:

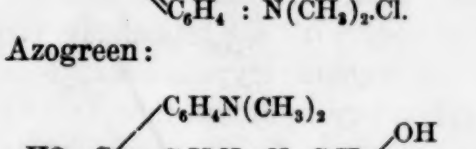
1. Chrome violet:



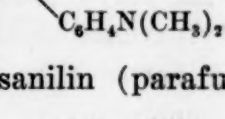
2. Chromeblue:



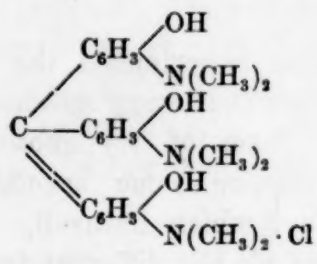
3. Azogreen:



4. Pararosanilin (parafuchsin):



5. Ortho-tri-oxy-hexa-methylpara-rosanilin:



Besides these colors Ehrlich investigated representatives of other groups of coal-tar colors, but found them inferior to those described.

The amount of work done by him can hardly be realized. It must be considered that many of the colors used had to be synthetized, as they were not commercial articles; they had then to be tested for toxicity on various species of animals, and finally their effect on trypanosoma had to be established. Of the immense material investigated only about ten substances stood the test.

There can be no doubt that thus far atoxyl has proved the most effective remedy for sleeping sickness, as it frequently causes marked improvement even

in severe cases of this disease. It is difficult to say, however, whether it is a true curative agent, since the disease is apt to run a prolonged and insidious course, and a long time, therefore, is required to judge whether a patient is actually cured. Much also depends upon the virulence of the parasite; thus, for instance, Ehrlich, who experimented with a particularly virulent strain of nagana trypanosoma, found it more refractory to atoxyl than other forms of this parasite. In this series of experiments he made the very interesting observation that acetylparaaminophenyl arsinic acid acted even better than atoxyl and proved less poisonous to mice. On the other hand, this substance was far more poisonous in other animals, such as guinea pigs or horses. Curious to say, the administration of acetylparaamidophenyl arsinic acid made "dancing mice" of the treated animals.

From these experiments the conclusion may be drawn that every species of animal and every form of trypanosoma would probably require some special curative agent, a fact which naturally makes the treatment of all the different trypanosoma affections far more difficult.

Like the parasite of relapsing fever, the trypanosoma may disappear from the blood under continued treatment, only to reappear at a later period when the disease is regarded as cured. There is thus a period of what may be termed immunity which may be of varying duration. Ehrlich found, for instance, that when mice inoculated with the trypanosoma of caderas were treated with trypanred the parasites apparently vanished completely from the blood, but in the course of twenty to thirty days reappeared and speedily caused death unless another course of treatment was substituted. Mesnil and Nicolle observed such a reappearance of the parasite after an interval of freedom of three to five months. It will be readily seen, therefore, that the disappearance of the trypanosoma in a case of sleeping sickness does not by any means signify that the patient is definitely cured. The blood has to be reexamined from time to time over long periods until an actual cure is assured. But even these tests are not absolutely positive, for it has been repeatedly shown that when the trypanosoma is no longer present in the blood and cerebrospinal fluid it may still be found in the bone marrow. Another curious circumstance is that an infected animal or human being apparently rid of the parasite and entirely well, may still be capable of transmitting the disease to others.

A further obstacle in the treatment of sleeping sickness and other trypanosoma affections is that the parasites after a time acquire a power of resisting the remedy used for their destruction. This is somewhat like the tolerance to drugs acquired by human beings. Thus, for instance, it has been found that the nagana trypanosoma when inoculated into mice could be made to disappear under treatment with fuchsin for a number of weeks, and upon their return could again be made to vanish by the same treatment. Finally, however, a time comes when this can no longer be accomplished. Evidently some change has taken place in the trypanosomes which enables them to resist what had previously proved destructive.

Browning thus has obtained strains of trypanosoma which have become resistant to the two groups of atoxyl, and to trypanblue, trypanred, etc., or even to three of these groups of substances. His researches show that this quality if once acquired is quite persistent and may even be transmitted to the progeny of the trypanosome. He believes that

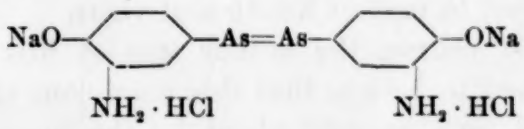
resistance to one parasiticide is true of other compounds of the same group, so that a strain of trypanosome resistant to trypanblue will also be resistant to trypanred—substances belonging to the same group, although otherwise differing widely chemically. It is a fortunate fact, however, that the parasite may still be successfully attacked by compounds belonging to other chemical groups. Probably the Ehrlich side-chain reaction best explains the mode of action of the various remedies used in the treatment of trypanosome diseases. According to this theory, the trypanosome, like a simple cell, contains various atom groups, the so-called chemoreceptors, which enter into a chemical relationship with the germicide. In the case of germicides belonging to the same class, like trypanred and trypanblue, the same atom group of the cell is attacked, while other atom groups react with other classes of antiparasitic agents, as for instance, atoxyl, parafuchsin, etc.

This theory also gives a clue in the treatment of trypanosome diseases, since it shows that instead of attacking simply one atom group of the parasite with substances with which it will enter into chemical relationship it is better to attack simultaneously several atom groups. It is like storming a fortress from various points instead of attacking one point alone.

As shown by Ehrlich, the effect of the atoxyl treatment may be increased by the simultaneous administration of trypanred, trypanblue, or fuchsin, and by such combinations it may be possible to achieve the essential aim, which is to rid the organism of the parasites in the shortest possible time.

While these investigations were going on, Uhlenhuth and Salmon published some brilliant successes obtained with atoxyl in the treatment of syphilis. Unfortunately, however, several cases of blindness were reported from the use of this remedy. The results achieved, however, were so promising that Ehrlich took up with renewed vigor the fight against the spirochete of syphilis with arsenical preparations. Soon atoxyl was replaced by arsacetin, the above-mentioned acetyl derivative of atoxyl, with even greater success, but without complete elimination of dangerous after-effects.

The constitution of atoxyl, elucidated by Ehrlich, and that of arsacetin permitted of a great variety of substitutions, and innumerable arsenic derivatives were synthetized and tested as to their effectiveness in the destruction of the spirochetes and as to their degree of toxicity upon the animal body, the object in view being that in the doses required to kill the parasite they must be free from any poisonous action upon the patient. The culmination of this long series of experiments is the wonderful Ehrlich-Hata 606, which is chemically p.p. dioxy m.m. diamido arsenobenzol in the form of the hydrochloride of its sodium salt:



A perusal of the publications appearing in the medical press on the use of this remedy is like reading tales from wonderland. With a remarkable unanimity it is stated that in less than no time the manifestations of the disease disappear, and that a condition of well being soon follows. During the 14 months of medical investigation of the drug, about fifteen thousand cases having been reported to Ehrlich, no ill-effects traceable to its use when properly administered have been observed. As reported at a meeting in Frankfort a.M., at which Ehrlich was present, two hundred

patients who were at the threshold of death had been saved from the grave by one injection.

But not only the spirochete of syphilis has been successfully attacked with this remedy, but also the spirillum of relapsing fever.

The wonderful effect of 606 and the hopes that can be entertained as to its ultimate field of utility are perhaps best illustrated by the following report of a case, published by Dr. K. Taege in the *Münchener med. Wochenschrift*, p. 1725.

The mother became infected with syphilis during pregnancy, and the child, when born, presented all the characteristic symptoms of the disease in a milder degree. It was decided to try the new treatment on the mother in the hope that the child might also obtain sufficient of the remedy through the breast milk to participate in the cure. Strange to relate, in both mother and child an improvement began to set in the third day after the injection of the drug, and as early as the fifth day all signs of the disease had almost completely vanished, and the child was practically restored to perfect health and vigor.

Of course, the author was at first inclined to believe that this marvelous effect had been brought about by the transmission of a certain amount of 606 in the milk or perhaps through the agency of arsenous acid split off from the combination; but this proved entirely erroneous, for examination of the milk with the Marsh test failed to reveal any sign of organic arsenic, while decomposition of the milk with HCl and $KClO_3$ gave only traces of inorganic arsenic.

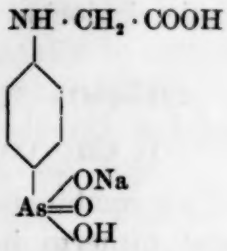
On appealing to Professor Ehrlich for an explanation, he ventured the opinion that the sudden destruction of the spirochete in the mother might have set free a large amount of toxic matter from the dead parasites, and that this in turn led to the production of antibodies by the cells, which, when transmitted through the milk, exerted the curative effect upon the child.

What an immense difference between the present-day theories and treatment and those in vogue towards the end of the year 1496 as described in a letter of the Duchess Beatrice of Milan to her sister Isabelle, Duchess of Mantua, whose husband suffered from the "French disease," as syphilis was then called. Beatrice had been asked for the loan of the services of Leonardo da Vinci, the famous painter, sculptor, mechanical engineer and inventor of flying machines, but her husband would not part with his artist friend and to sweeten the refusal, Beatrice gives her the following advice at the end of the letter: "I send your illustrious husband, Signore Francesco, a recipe against the French disease, which has been devised by our body physician, Luigi Marliani. It is claimed that it helps. The mercury inunction must be applied in the morning on an empty stomach on the uneven days of the month after the new moon. I have heard that this disease has no other cause than the fatal meeting of some certain planets, especially Mars and Venus."

To return to the subject, a marked activity in this branch of synthetic chemistry soon followed these experimental studies of arsenical preparations. Thus arsenic was produced in its colloidal form by the reduction of arsenic compounds by means of pyrocatechin, amidophenol, etc., in the presence of albumen. An arsenic proteid was obtained by the action of arsenic trichloride on vegetable albumen free from nuclein. This arsenic compound passes unchanged through the stomach and is decomposed only on reaching the intestine.

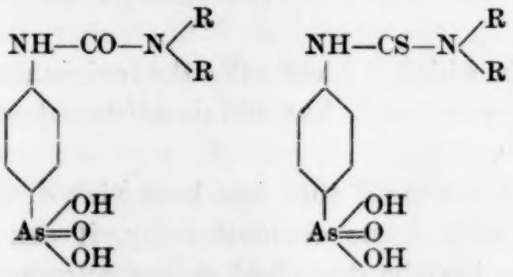
Atoxyl, or paraaminophenylarsinic acid, now called arsanilic acid, has been con-

verted into glycines by the action of chloracetic acid:



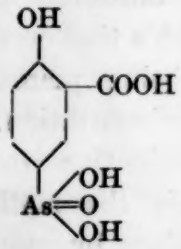
All kinds of azo and polyazo derivatives were obtained by diazotizing atoxyl and combining with the usual coupling substances, and the amido group was converted by diazotization into the oxy group or substituted by halogen.

Urea and thio-urea compounds were made from atoxyl, and substances of the following composition were obtained:

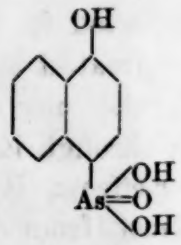


Besides the paraamido compound, the metaamido combination has been produced and employed for the various syntheses.

An arsinosalicylic acid has been obtained by resorting to anthranilic acid instead of anilin in the reaction

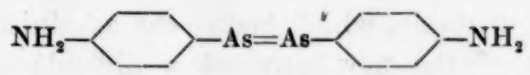


and by the use of alpha naphthylamin an alpha naphthol arsinic acid was produced

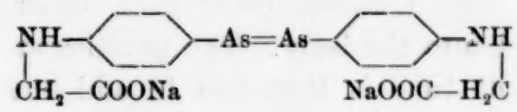


By various forms of reduction Ehrlich obtained from atoxyl a product called p. aminophenylarseneoxid

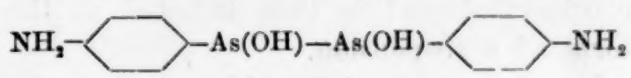
and diaminoarsenobenzol



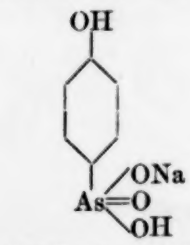
A derivative of the latter substance is spirarsyl of the formula:



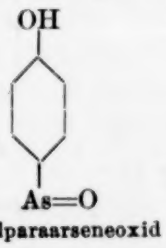
By reduction with sodium amalgam diaminodihydroarsenobenzol is obtained



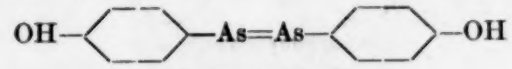
From oxyphenylarsinic acid, which is produced by heating phenol with arsenic acid, phenolparaarseneoxid is obtained by reduction, which upon treatment with hydrosulfite furnishes paraarsenophenol



Oxyphenylarsinic acid



Phenolparaarseneoxid

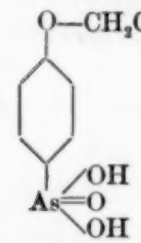


P. Arsenophenol

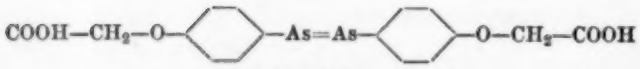
"606" is also a derivative of oxyphenylarsinic acid, and is produced from it by nitrating and reducing the thus obtained nitrooxyphenylarsinic acid to the amidooxyphenylarsinic acid. By treatment with weak reducing agents this substance furnishes the "606" preparation. As the formula shows, the product contains two atoms of trivalent arsenic, that is, the un-

stable form in contradistinction to the stable pentavalent form, in which arsenic occurs in atoxyl, arsacetin and the cacodylates. Owing to the presence of the two hydroxyl groups the product possesses acid character, enabling it to form weak salts with bases, and owing to the presence of the two amido groups it also has basic character, enabling it to form salts with acids. But either form of salt is of necessity unstable, which makes the administration of the new product a difficult one. The hydrochloride when dissolved in water is decomposed and liberates hydrochloric acid, which causes great pain when injected into the body. The practise at the present time is therefore to add enough alkali to the solution to neutralize the free acid, by which treatment the free base is precipitated and is then injected in the form of a suspension.

From oxyarylarsinic acids we obtain by condensation with chloracetic acid arylglycol arsinic acids, which upon reduction furnish arsenoarylglycolic acid

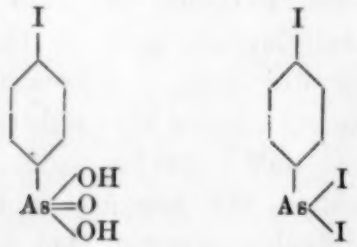


Phenylglycolarsinic acid

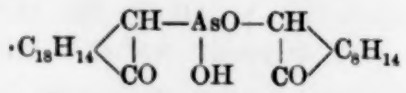


Arsenophenylglycolic acid

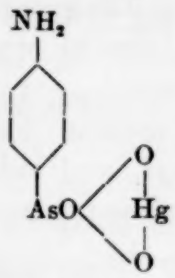
Among other substitution products we must mention an iodin derivative, the p.iodinphenylarsinic acid and its diiodide:



and a camphor combination, the dicamphorarylarsinic acid, obtained by the action of arsenictrichloride upon sodium camphor:



An interesting combination of the mercury treatment hitherto in use with the new method by means of the arsenic preparations is represented by the synthesis of the atoxylate of mercury



with which Uhlenhuth, the originator of the substance, has obtained excellent results.

If, after all that has been stated above, we now define chemotherapy, it can perhaps best be described as the science dealing with the treatment of internal parasitic diseases by means of preparations synthetized with the object of combining the maximum power of efficiency in the destruction of the greatest variety of protozoa with the minimum poisonous action upon the patient's tissues, this combination of properties being primarily established by animal experimentation.

In contradistinction to chemotherapy, serumtherapy is the method of treating bacterial infections by means of antibodies generated by the diseased organism itself.

If, as seems improbable from the brilliant results reported in such abundance by many of the greatest authorities in the medical world, the new remedy should suffer a setback through later observations of serious after-effects, it would not detract in the least from the magnificent

services which Ehrlich and his pupils have rendered humanity. Such vast progress has already been achieved in chemotherapy that it will necessarily be only a matter of a short time when it will become possible to definitely arrest the ravages of such terrible diseases as syphilis, recurrent fever and sleeping sickness. Perhaps cancer, the cause of which has been ascribed by some investigators to organisms resembling the spirochete of syphilis, will also be found amenable to chemotherapy.

This marvelous success of modern therapy is, in a large measure, due to synthetic chemistry, which in the past has already rendered invaluable assistance to the medical practitioner by furnishing him such efficient remedies as antipyrin, phenacetin, trional, veronal, hexamethylen-tetramin, and aspirin. How, in the light of these positive advances, can we explain the attitude of those few who are still opposed to progress in medicine to which our science has chiefly contributed. A few years ago when we celebrated the birth of synthetic chemistry by commemorating the fiftieth anniversary of Perkin's discovery of the first anilin color, one of these obstructionists stated in a discussion that he believed very few useful drugs had been put out by the manufacturing chemists, and that we should be better off if Perkin had never discovered coal-tar products. The anilin colors were cheap and gaudy and did not last, and the coal-tar drugs were in the same class. He believed that the good that coal-tar products had done was being neutralized by the harm.

Let us hope that after a closer study of the subject this short-sighted man has meanwhile learned that he is wrong in every particular; for there exist coal-tar dyes which are ever so much faster than any coloring matter supplied by nature, and coal-tar derivatives in the hands of competent physicians do as little harm as any active drug in the pharmacopœia.

In fact, it is no exaggeration to say that there is scarcely a department in medicine that has not directly benefited through the discovery of the coal-tar products and especially of the anilin dyes. It has provided the anatomist and pathologist with the means of staining various tissues and thus of studying not only their normal structure but the alterations caused by disease. It is the foundation upon which has been built the modern science of bacteriology, enabling the investigator in this field to distinguish between the different disease organisms and to determine their presence by various tests, and now it bids fair to equip the physician with the most potent weapons in the warfare against disease.

H. SCHWEITZER

NEW YORK CITY

THE INSTRUCTION OF LARGE UNIVERSITY CLASSES

THE great increase of students in universities has brought up the problem of instructing students efficiently in large classes. The problem presents so many difficulties, and is one that so many instructors are wrestling with, that we have thought that it might be of value to describe the methods of handling large classes in a physics course in which there are lectures, recitations and laboratory exercises.

In this course there are registered about 400 students. Two lectures are given each week together with one quiz and two two-hour laboratory periods. The course continues throughout the college year, and covers the usual range of topics of a course in general physics. The lectures are given on Monday and Wednesday mornings at nine o'clock and repeated at eleven o'clock on the same days, the class being divided equally for the two periods. Experience has shown that 200 is a maximum number of students for experimental lectures, even with a good lecture

room, this not only on account of seeing, but also on account of holding the attention of all students.

The quiz is given on Friday, and is based on the topics covered in the lectures. The quiz sections are made up of from 18 to 25 students, the plan being to keep the number down to 20 if possible. These sections meet throughout the day, not all of them at the same hour. A mimeographed quiz sheet is prepared under the direction of the lecturer, and forms the basis of the quiz. The quiz instructors meet with the lecturer before Friday for a discussion of the quiz sheet, thus securing uniformity of presentation.

The laboratory work runs parallel with the lectures, and frequent conferences between instructors in both courses gives unity of presentation and of topics, so that the two courses are practically one. With such large classes it is evidently necessary to have a large number of students scheduled for laboratory at the same hour. This means either a large section in one or two large rooms or else a number of small sections in smaller rooms. Small separate sections involve a considerable number of experienced instructors, each more or less independent, and this presents a difficult executive problem. Even with plenty of money it is not easy to get and keep a large number of instructors of this kind, and harmony among them is also not always easy to maintain. Then it is not always possible to get a large number of separate laboratories. We have used the plan of a large section, in a large laboratory, with an efficient executive aided by assistants, and have duplicated apparatus throughout so as to unify the instruction. Three experiments are run at one time, and there are ten sets of apparatus for each experiment. Thus if two students work with one set of apparatus, 60 students can be accommodated in a section. The student performs these experiments in rotation, one at each meeting of the section, thus taking three periods. The fourth period is not taken for experimental work, but half of it is used for an oral or written quiz on work of the preceding experiments and the remaining half for a discussion of the next set of experiments. The practise is also followed whereby the section is divided into three parts, each division meeting with an instructor for a few minutes at the beginning of the laboratory period for a discussion of the experiment about to be performed. Students are supplied with printed directions written especially for the apparatus and experiments of this course.

On arriving at the laboratory, the student is given two blank data forms that indicate the experiment to be performed, and the table in the laboratory at which the student is to work. The student is given also a key to an apparatus locker. He secures the necessary apparatus and takes it to the table assigned to him. Presently he is joined by a second student who has received the same assignment as the first student except that he is given only one blank data form and no key. These two students perform the experiment together, record the data in pencil on the third blank data form, copy this data in ink on the two remaining data forms. Meanwhile the instructors go around to give help when needed. The general rule is to have one instructor for each fifteen students, but the instructors need not be all experienced teachers. One instructor is in charge and is responsible for the period. Upon completion of the observations the apparatus is returned to the locker, the table is cleaned up and the three data forms and key are presented to the instructor. The data forms are stamped with the date, the pencil copy being retained by the instructor, and an inked copy by each student to be used in writing his record of the experiment. This record is due a week later bound in a printed manila cover.

The laboratory procedure is given in detail in order that several fundamental principles may be brought out. The method is such that a section of 60 students may be started in five minutes, and the instructors are then free to go around, asking questions and giving advice and help. By having the apparatus in lockers, the laboratory is kept orderly at all times. Furthermore, it is easy to keep

account of the apparatus. Practically no apparatus has been lost in years. Each student on opening the apparatus locker must check over the pieces and report anything missing or broken. If such a report is made, the responsible student is located at once by consulting the records of the previous section. The use of inked data sheets also helps to reduce temptation. The paper of the data blank is such that any erasure of the ink is detected at a glance. The student is further deterred from dishonesty because of the knowledge that the instructor has a copy of the original data.

The "doctoring of results" by students is due to their desire to secure a better grade. With this thought in mind, a procedure has been established minimizing the credit given for the data taken, and magnifying the other parts of the experiment. The actual grading is made up according to the following values: neatness and condition of place of working 10 points, diagram of apparatus 5 points, method of working 10 points, theory of experiment and answers to questions 40 points, data taken 35 points, with a total of 100. A form printed on the cover shows the amounts allowed for each part of the work, so that the student can see where he is deficient. The method of grading the data is such that very accurate results are not required. Average results are not severely graded, so that a student learns he will not suffer severely if his observations are those of average conditions. The practise of requiring very accurate results with the penalty of a repetition of the experiment when the data shows a departure from these required results, encourages the practise of "doctoring data." The present plan of placing the credit on the *interpretation* of the results seems better in theory and is found more satisfactory in practise. Of course work that is careless or very poor must be repeated, and for the first few weeks of the course a considerable number are required to repeat or to rewrite work. Excellent work is encouraged by marking it with exceptional grades.

It is realized that the above plan followed in the laboratory work is to be criticized because it tends to make the laboratory a machine that will turn out so many students all in the same way. It is hard to see how this can be entirely avoided with large classes. An effort is made to keep quiz sections small in number of students, so that frequent opportunities are offered for expression of original ideas. The development of individuality is also considered in writing the directions for performing experiments.

Final examinations are given at the end of each semester in both the lecture and the laboratory work. The final examination, however, is given a weight of only a third or less in the total grade, the class work and written quizzes counting most in putting a mark on the student's work.

Some of the methods which we have used have been chosen because of local conditions, but many of our conditions are similar to those found in all larger institutions, particularly in institutions with large engineering colleges. We change details of the course each year, but the above represents a general plan which has been found efficient in instruction, and easy to manage.

A. P. CARMAN
F. R. WATSON

UNIVERSITY OF ILLINOIS,
November, 1910

THE AGRICULTURAL PRODUCTION OF THE UNITED STATES[1]

YEAR after year it has been my privilege to record "another most prosperous year in agriculture." Sometimes the increased prosperity has been due to weather unusually favorable to agriculture, sometimes to higher prices, caused either by a greater yield or demand, or by a scant production, but usually the advance in farmers' prosperity has been in spite of various drawbacks. It would seem that this country is so large in extent and has such varied climate, soil and crops that no nation-wide calamity can befall its farmers. Combined with this strong position in agriculture, the nation may now begin to derive

[1] From the annual report of the Secretary of Agriculture.

increased confidence in its agriculture because of improvements that are permeating the whole country in consequence of a grand movement sustained by the National Department of Agriculture and the various state agencies.

Nothing short of omniscience can grasp the value of the farm products of this year. At no time in the world's history has a country produced farm products within one year with a value reaching $8,926,000,000, which is the value of the agricultural products of this country for 1910. This amount is larger than that of 1909 by $305,000,000, an amount of increase over the preceding year which is small for the more recent years.

The value of farm products from 1899 to the present year has been progressive without interruption. If the value of that census year be regarded as 100, the value of the agricultural products of 1900 was 106.4; that of 1901 was 112.7; that of 1902 was 119.1; that of 1903 was 124.8; that of 1904 was 129.8; and that of 1905 was 133. The year 1906 was an extraordinary one for agriculture, both in quantity and in value of production. The value increased to 143.4, as compared with 100 representing 1899. In the next year, 1907, the value of agricultural products rose to 158.7; in the next year, 1908, to 167.3; in 1909 to 182.8; and in 1910 to 189.2, or almost double the value of the crops of the census year eleven years preceding. During this period of unexampled agricultural production, a period of twelve years during which the farmers of this country have steadily advanced in prosperity, in wealth and in economic independence, in intelligence and a knowledge of agriculture, the total value of farm products is $79,000,000,000.

In the statement that follows concerning the crop quantities and values for 1910, no figures should be accepted as anticipating the final estimates of this department to be made later. Only approximations can be adopted, such as could be made by any competent person outside of this department. All values are for products at the farm, unless otherwise stated, and in no item are values at the produce or commercial exchange.

A national asset amounting to 3,000 million bushels, worth 1,500 million dollars, is found in the corn crop. Its production this year was 3,121,381,000 bushels, a crop that exceeds that of even the great agricultural year 1906. It is greater than the average crop of the preceding five years by 14 per cent. A notable feature of corn production this year is the growing importance of the south. This has been manifested in a small way in very recent years, but now the increased magnitude of the crop in that section, both absolute and relative to national production, forces itself upon the attention. Let a comparison be made with corn production in the south in the census year 1889, or twenty-one years ago. At that time the South Atlantic states produced only 6.2 per cent. of the national crop of corn. This year they produced 9.1 per cent., or an increase relatively of about one half. The relative increase for the south central states is even greater, being from 14.8 per cent. of the national crop of 1889 to 23.4 per cent. in 1910. Then the south produced hardly more than one fifth of the national crop; now it produces one third. The power that this increased corn production gives to southern farmers with respect to independence, release from buying feeding stuffs, in producing meat, and maintaining dairy and other domestic animals is well understood.

While the value of this corn crop is below that of 1909 and also of 1908, its amount belongs to stories of magic. It can hardly be reckoned at less than $1,500,000,000, a sum sufficient to cancel the interest-bearing debt of the United States, buy all of the gold and silver mined in all of the countries of the earth in 1909, and still leave to the farmers a little pocket money. The corn crop is a national asset in more than one sense. It is not merely wealth in existence for the time being, but it is an asset of perpetual recurrence. Year after year, throughout the ages, a stupendous amount of corn, with incredible value, can be produced.

The cotton crop, including seed, is worth this year only three fifths of the value of the corn crop; the wheat crop only two fifths; the hay crop, less than one half. All of the cereals, except corn, are together worth only three fourths as much. The great allied iron and steel industries had in the latest census year for which results have been published, 1904, a production worth only 60 per cent. of the value of this year's corn crop.

For many years the cotton crop was fourth in value among the crops, being exceeded usually by corn, wheat and hay. But in those days the price of cotton was very low. The crop of this year may be worth in lint and seed around $900,000,000 at the farm, or more than the corn crop was worth in any year prior to 1901, or more than the wheat or hay crop was ever worth. Apparently the cotton crop of this year, including seed, is worth $129,000,000 more than the crop of last year, and that crop was far above any previous one in value. During the last five years the cotton crop had an average value of $685,000,000, so that the value for this year is 13 per cent. above the five-year average. The number of bales in this year's cotton crop will be determined by the Bureau of Statistics of this department next month, and at the present writing no forecast of that estimate can be suggested. From commercial sources, however, it is evident that the cotton production of this year will be considerably short of being a record breaker, although possibly it may be the fourth in order of magnitude that this country has produced. The average cotton crop of the preceding five years had a weight which perhaps is not far from most of the commercial estimates for the crop of this year.

Wheat has often contended with hay as to precedence in value and the place in 1910 goes to hay, notwithstanding its short crop. The value of the hay crop is about $720,000,000, an amount which has been exceeded but once, and that in 1907, when the crop was worth $744,000,000. Indeed, the value of the crop of this year is much above that of the high crop values of other preceding years, illustrating the principle that a somewhat deficient crop is usually worth more in the aggregate than an abundant one. The value of the crop of this year is 13 per cent. above the average of the preceding five years. The quantity of the hay crop is 60,116,000 tons, and has been exceeded a dozen times. It is 5 per cent. below the average crop of the preceding five years. The feeding value of the hay crop, however, is greater than its tonnage implies. Alfalfa has entered into the production of this crop in recent years and has now become in itself a crop of large proportions. In relative geographic distribution, the hay crop has changed perceptibly during the twenty-one years since the census year of 1889. During the interval the North Atlantic states have increased their production of the national crop from 24.3 to 27.8 per cent.; the western division, 7.9 to 16.4 per cent.; the South Atlantic, from 3.1 to 3.9 per cent.; the south central, from 3.3 to 5.8 per cent.; the two southern groups of states, from 6.4 to 9.7 per cent.; and consequently, the north central states have lost relatively in a marked degree, or from 61.4 to 46.1 per cent. of the national crop.

Fortunately the wheat crop is divided into two sowings, autumn and spring, and consequently it is not improper to regard wheat as having two crops. These to some extent cover the same territory, but they belong largely to different geographic areas, subject to different climatic accidents, with the frequent result that one of the crops is a successful one and the other is not. Such was the fact this year, when the winter crop was a large one and the spring-sown crop suffered from severe drought. The production of both crops this year is 691,767,000 bushels, or substantially the average of the preceding five years, whereas the value is about $625,000,000, or 7.6 per cent. above the five-year average. The quantity of this year's wheat crop has been exceeded four times, but the value has been exceeded only once, in 1909, although the crop of 1908 was nearly as valuable. Wheat is another crop that has undergone perceptible change in relative geographic distribution since the census

year 1889, but in a less degree than corn and hay. During the twenty-one years the fraction of the national crop produced in the North Atlantic states declined from 6.8 to 5.9 per cent.; in the north central states, from 68.6 to 62.9 per cent.; whereas there were increases in the other geographic divisions—from 5.9 to 6.6 per cent. in the South Atlantic; from 5.2 to 9.7 in the south central, and from 13.5 to 14.9 in the western states.

Easily the fifth crop in point of value is oats, a position that it has long occupied. The value this year is probably over $380,000,000 and has been exceeded in this respect only by the crop of 1909. Compared with the average value of the five preceding years, this year's value is 12 per cent. greater. In quantity the crop of this year is a magnificent one. For the second time in the history of this country the crop exceeds one billion bushels, the precise estimate standing at 1,096,396,000 bushels, or about 90 million bushels above the great crop of 1909. The crop of this year is 22 per cent. greater than the average of the five previous years. The production of this crop has shifted somewhat into the south central and western states in comparison with the national production since 1889. The share of the North Atlantic states has declined from 10.8 to 8.6 per cent.; of the South Atlantic states, from 2.9 to 2 per cent.; of the north central states, from 79.7 to 77.2 per cent.; the south central states gained the difference between 4.7 and 6.5 per cent.; the western states the difference between 1.9 and 5.7 per cent.

Next in order of value is the potato crop, which was exceeded in only two or three former years. Compared with the average value of the five previous years, the value for this year is 1 per cent. greater. With the exception of the crop of 1909, which was in a degree an over-production, the crop of potatoes this year was the largest ever grown in this country, the preliminary estimate of this department being 328,787,000 bushels. This quantity is 8 per cent. greater than the average for the preceding five years.

Beet-sugar production in 1910 has been subject to vicissitudes of climate and other influences. A smaller acreage of sugar beets was planted in Colorado; there was a lack of moisture necessary to a full crop in Utah and Idaho; whereas the production of California, Michigan, Wisconsin and other states considerably exceeds that of last year, partly due to three new operating factories. Five new factories will be in operation in 1911—two in California and one each in Colorado, Utah and Nevada. All acreage planted this year returned beets excellent in both quality and quantity.

It is too early now to forecast accurately the production of beet sugar for 1910, but the indication is that the crop will be about as large as that of 1909, or, say, 512,000 short tons. The factory value of this sugar is about $51,000,000, or hardly less than the value of the crop of 1909, which was the record year.

Commercial estimates indicate that the cane-sugar crop of this year will be about 347,000 short tons, which has been frequently exceeded in recent years. The factory value of this sugar is about $28,000,000, an amount that has been exceeded in four years.

If prospects are realized, the entire sugar crop of factory production, beet and cane combined, will be about 859,000 short tons, or a production that has been exceeded in only one year, 1909. In factory value the two sugar crops will equal about $79,000,000, and if to this be added the value of molasses, syrup, beet pulp and sorghum and maple products, the combined value of the production of sugar, syrup and molasses, with subsidiary products, is about $97,000,000, or only $4,000,000 under the high-water mark of 1909.

The tobacco crop has slightly exceeded the production of the record year 1909, and its 967,150,000 pounds are 26 per cent. above the average production of the five preceding years. Apparently the tobacco prices of 1909 are barely maintained for the crop of this year, and the total value of the crop is therefore about the same as it was for the crop of 1909, or, say, $95,000,000. No tobacco crop previous to 1909 was worth its amount by fully 20 million dollars. Tobacco, under the better prices of recent years, is steadily climbing upward in

production. The average prices for the last five years, including 1910, have been 10 cents a pound and a little better. It seems to be required that the average price of the crop, all types and grades included, shall not decline if this crop is to maintain its increasing production.

Barley this year has hardly maintained the average production of the preceding five years, the production of this year being 158,138,000 bushels, as compared with the five-year average of 161,240,000. This year's crop, however, has been exceeded only three times, in 1909, 1908 and 1906. In point of value the crop of 1910 has been exceeded only in 1907, and the value of this year is 16 per cent. above the average of the previous five years. The price of barley suddenly increased about 60 per cent., to 66.6 cents in 1907, after which it declined to about 55 cents a bushel in 1908 and 1909, but a higher price than this is indicated for the crop of this year. In relative geographic redistribution of the barley crop since 1889, the share of the North Atlantic states has declined from 12.2 to 2 per cent., while the share of the north central division of states has increased from 60.3 to 62.8 per cent. and that of the western states from 26.9 to 34.4 per cent.

Flaxseed follows barley in order of importance of value of crop. At this writing the indication is that the value of the flaxseed production of this year will be about $33,000,000, which would be the record amount were it not for the greater value of the crop of 1909. Compared with the previous five years, the value of this year's crop is 13 per cent. greater. While the value of this year's crop remains near the top, the production is far below that of recent years, the preliminary estimate being 15,050,000 bushels. The low production and high value of the flaxseed crop are reconciled in the high price of flaxseed per bushel beginning early in this year. The November 1 price at the farm in 1908 was $1.08; in 1909, same month, $1.40, and in 1910, same month, $2.29.

Next in order of value is the rye crop, the 32,088,000 bushels being worth at the farm about $23,000,000. This crop is constant in production and varied little in value in recent years. A larger share of the national crop is now produced in the North Atlantic states than in 1889, the increase being from 28.4 to 33.9 per cent. During this time the north central states have declined in their share from 63.2 to 57 per cent.

Rice production in 1910 remains substantially at the figure of 1909, or, say, a little over 1,000,000,000 pounds of rough rice. No year previous to 1909 produced as large a crop; it exceeds the average of the previous five years by 25 per cent. The price of rice, however, has declined, so that the crop of this year is worth hardly $16,000,000, or about the same as the crops of 1906 and 1907. This value has been exceeded in 1908 and 1909, so that the value of this year's crop is about 2 per cent. below the five-year average.

The estimates of persons outside of this department indicate that the hop crop of this year will be 13 per cent. below the average quantity of the preceding five years, and the smallest crop in a dozen years or more. The farm price of hops in 1910 has improved somewhat over the average of the previous five years, so that the total value of the crop of this year is 3 per cent. above the five-year average.

For transportation purposes and as a rough indication of the production of all cereal crops, a statement of the total production of these crops in bushels is interesting. In no previous year has the production of these crops equaled the 5,140,896,000 bushels of the cereals of 1910. The production of this year is 13 per cent. above that of the five-year average, which is about 4½ billion bushels. In value, however, the cereals of this year fall below that of 1908 and 1909, principally on account of the decline in the farm price of corn. This year's value is $2,710,000,000, or about $230,000,000 below the total for 1909 and $50,000,000 below that of 1908; however, it is 11 per cent. above the five-year average.

This is the year of highest production for corn, oats, the total of all cereals, and for tobacco. But the only crop that reached its highest value this year is cotton. The list of crops that stand next to the highest, either in

quantity or value, or both, is much larger than the foregoing. In production next to the highest year are found for 1910 the crops of rice, hay, beet sugar and the total for all sugar. In the list of the crops that are next to the highest in value are wheat, oats, barley, tobacco, flaxseed, beet sugar and the total for all sugar. The potato crop was third in order of quantity and the corn crop and the total for all cereals were third in value. Barley and rye were fourth in production and potatoes fourth in value. Fifth in production was wheat and fifth in value rice.

The average production of the five years preceding 1910 includes the remarkably productive year 1906 and was generally a period of vigorous production. Notwithstanding the high character of the period, the production of 1910 is above the five-year average in the case of corn, oats, rice, rye, buckwheat, beet sugar, the total for all sugar, potatoes, tobacco and wool. In comparison with the average of the preceding five years the value of the crops of this year was greater in the cases of corn, wheat, oats, barley, rye, buckwheat, cotton, beet sugar, the total for all sugar, flaxseed, hay, potatoes, tobacco and hops.

The value of the farm products of 1910 shows both gains and losses in comparison with 1909. A gain of $130,000,000 is made for cotton lint and seed, $30,000,000 for hay and $3,000,000 for barley. A loss was suffered in wheat, amounting to $104,000,000; corn, $98,000,000; oats, $26,000,000; potatoes and wool, $23,000,000 each.

The farm value of the cereal crops declined $230,000,000 in 1910 from 1909, and the value of all crops declined $119,000,000. A gain was made, however, in the value of animal products, amounting to $424,000,000. It has been a year of high prices for meat and animals, for poultry and eggs and for milk and butter, and for these reasons the total value of all farm products increased in 1910 $304,000,000 above the estimate for 1909.

THE MINNEAPOLIS MEETING OF THE AMERICAN ASSOCIATION

The sixty-second meeting of the American Association for the Advancement of Science, and the ninth of the "convocation week" meetings, will be held in Minneapolis, December 27 to 31, 1910, at the invitation of the University of Minnesota.

A meeting of the executive committee of the council (consisting of the general secretary, the secretary of the council, the permanent secretary and the secretaries of all of the sections) will be held at the office of the permanent secretary, in the Hotel Radisson, at noon, on Monday, December 26.

The opening session of the association will be held at 8 o'clock P.M. on Tuesday, December 27, in the First Baptist church, 10th Street and Harmon Place.

The meeting will be called to order by the retiring president, Dr. David Starr Jordan, who will introduce the president of the meeting, Dr. A. A. Michelson. There will be short addresses of welcome and a reply by President Michelson. The annual address of the retiring president, Dr. David Starr Jordan will then be given on "The Making of a Darwin."

At 9.30 there will be a reception to the members of the association and affiliated societies, after the presidential address, in the parlors of the Hotel Radisson, the headquarters.

On December 28 at 9 A.M. the Council will meet in Room No. 101, Folwell Hall, University of Minnesota.

The sections will organize in their respective halls and the regular program of papers will begin.

Addresses by retiring vice-presidents will be given at 2.30, as follows:

Vice-president Brown, before the Section of Mathematics and Astronomy. Title: The Relations of Jupiter with the Asteroids.

Vice-president McPherson, before the Section of Chemistry. Title: The Formation of Carbohydrates in the Vegetable Kingdom.

Vice-president Brock, before the Section of Geology and Geography. Title: Northern Canada.

Vice-president Ritter, before the Section of Zoology. Title: The Controversy between Mechanism and Vitalism: Can it be Ended?

A session will be held in St. Paul in the evening, the arrangements for which are in

charge of the St. Paul local committee and will be announced in the regular program. A public lecture will be given by Mr. A. B. Stickney on: Should Practical Agriculture and Field Athletics be added to the Curriculum of the City Public Schools?

The Section of Physiology and Experimental Medicine will hold a symposium on December 29, at 9.30 on Diseases Caused by Filterable Organisms. The topic will be subdivided into the following: Human diseases, animal diseases, plant diseases, experimental diseases.

Addresses by retiring vice-presidents will be given at 2.30, as follows:

Vice-president Bauer, before the Section of Physics. Title: The Physical Bearing of Problems in Terrestrial Magnetism.

Vice-president Minot, before the Section of Physiology and Experimental Medicine. Title: The Method of Science.

Vice-president Hayford, before the Section of Mechanical Science and Engineering. Title: The Relations of Isostasy to Geodesy, Geology and Geophysics.

Vice-president Holt, before the Section of Social and Economic Science. Title: Causes and Effects of High Land Values.

On December 30 there will be a symposium on Aviation under the auspices of Section D.

All meetings of the sections of the association and of affiliated societies will be held at the University of Minnesota. Beginning with Wednesday, the sections and societies will hold their regular sessions. It is expected that there will be joint meetings when the same subjects are covered, and that additional meetings will be arranged of general interest to all members of the association. No definite arrangements have been made as yet for some of the general evening functions after Tuesday night—such as dinners and meetings of special societies and groups, smokers and informal meetings.

Attention is called to the following resolutions of the council:

Resolved, That at the annual meetings of the association each section shall prepare a program of general interest to scientific men, which shall occupy an afternoon session, or, if desired by the sectional committee, both morning and afternoon sessions of the same day. This program shall include the vice-presidential address.

Resolved, That, as it is the policy of the association to avoid competition with programs presented before the special national societies, the sections are recommended to arrange no programs of special papers for the annual meetings: *provided*, that the corresponding national society meets at the same time and place.

The following societies have indicated their intention to meet in Minneapolis during "convocation week" in affiliation with the association:

Botanical Society of America.—Meets on Tuesday, Wednesday and Thursday, December 27, 28 and 29. Will hold joint session with Section G as in former years. Room 29, second floor, Pillsbury Hall. Secretary, Dr. George T. Moore, Missouri Botanical Garden, St. Louis, Mo.

Botanists of the Central States.—Meets in conjunction with Section G and Botanical Society of America. Room 29, second floor, Pillsbury Hall. Secretary, Dr. Henry C. Cowles, University of Chicago, Chicago, Ill.

American Chemical Society.—Meets on Wednesday, Thursday, Friday and Saturday, December 28 to 31, in Chemical Laboratory. Secretary, Professor Charles L. Parsons, New Hampshire College, Durham, N. H.

Entomological Society of America.—Will hold meetings on Tuesday and Wednesday, December 27 and 28, 1910. Room 23, School of Mines Building. Secretary, Professor C. R. Crosby, Cornell University, Ithaca, N. Y.

American Association of Economic Entomologists.—Will hold sessions on Wednesday and Thursday, December 28 and 29, 1910. Room 24, School of Mines Building. Secretary, A. F. Burgess, Gipsy Moth Parasite Laboratory, Melrose Highlands, Mass.

American Federation of Teachers of the Mathematical and Natural Sciences.—Will hold meetings on Friday and Saturday, December 30 and 31, 1910. Joint meetings with Section L will be held on Friday, December 30, 1910. Room 301, Folwell Hall. Secretary, Eugene R. Smith, Polytechnic Preparatory School, Brooklyn, N. Y.

American Mathematical Society (Chicago Section).—Will hold sessions on Wednesday, Thursday and Friday, December 28, 29 and 30, in Room 102, Folwell Hall. Joint session with Sections A and D on Friday, December 30, in Room 209, Folwell Hall. (Report will be presented from the

Committee on the Teaching of Mathematics to Engineering Students.)

American Microscopical Society.—Will hold meetings on Wednesday and Thursday, December 28 and 29, 1910. Room 7, ground floor, Pillsbury Hall. Secretary, Dr. Thomas W. Galloway, James Millikin University, Decatur, Ill.

American Nature-Study Society.—Will meet on Friday, December 30, 1910. Room 308, Folwell Hall. Secretary, Professor Fred. L. Charles, University of Illinois, Urbana, Ill.

Western Philosophical Association.—Meets on Tuesday, Wednesday and Thursday, December 27, 28 and 29. Joint session with American Psychological Association on Thursday morning, December 29. Room 322, Folwell Hall. Secretary, Mr. Bernard C. Ewer, 614 Clark Street, Evanston, Ill.

American Physical Society.—Meets in conjunction with Section B, A. A. A. S. Physical Laboratory. Secretary, Professor Ernest G. Merritt, Cornell University, Ithaca, N. Y.

American Phytopathological Society.—Will hold meetings on Wednesday and Thursday, December 28 and 29, 1910. Room 29, second floor, Pillsbury Hall. Secretary, Dr. C. L. Shear, U. S. Department of Agriculture, Washington, D. C.

American Psychological Association.—Meets on Wednesday, Thursday and Friday, December 28, 29 and 30. Rooms 311 and 321, Folwell Hall. Secretary, Professor Arthur H. Pierce, Smith College, Northampton, Mass.

Sullivant Moss Society.—Will hold meetings on Tuesday and Wednesday, December 27 and 28, 1910. Room 4, ground floor, Pillsbury Hall. Acting Secretary, Dr. George H. Conklin, 1204 Tower Avenue, Superior, Wisconsin.

American Society of Zoologists (Central Branch).—Meets on Thursday and Friday, December 29 and 30, in joint session with Section F. Room 35, second floor, Pillsbury Hall.

By virtue of a resolution of the council of the association the programs of affiliated societies will be published by the association in the general program to be issued on the morning of December 27.

The local executive committee for the Minneapolis meeting is as follows: Wilbur F. Decker, *Chairman,* Frederic E. Clements, *Secretary,* Leroy J. Boughner, Frederic B. Chute, James F. Corbett, James F. Ells, Wallace G. Nye, Henry F. Nachtrieb, Edward E. Nicholson, Francis C. Shenehon, Albert F. Woods, Frederick J. Wulling.

The officers of the American Association for the Minneapolis meeting are:

President—Albert A. Michelson, University of Chicago, Chicago, Ill.

Vice-presidents:

A—Mathematics and Astronomy—Eliakim H. Moore, University of Chicago, Chicago, Ill.

B—Physics—Edward B. Rosa, Bureau of Standards, Washington, D. C.

C—Chemistry—George B. Frankforter, University of Minnesota, Minneapolis, Minn.

D—Mechanical Science and Engineering—A. Lawrence Rotch, Blue Hill Meteorological Observatory, Hyde Park, Mass.

E—Geology and Geography—Christopher W. Hall, University of Minnesota, Minneapolis, Minn.

F—Zoology—Jacob Reighard, University of Michigan, Ann Arbor, Mich.

G—Botany—Robert A. Harper, University of Wisconsin, Madison, Wis.

H—Anthropology and Psychology—Roland B. Dixon, Harvard University, Cambridge, Mass.

I—Social and Economic Science—Hon. Theodore E. Burton, Cleveland, Ohio.

K—Physiology and Experimental Medicine—Frederick G. Novy, University of Michigan, Ann Arbor, Mich.

L—Education—A. Ross Hill, University of Missouri, Columbia, Mo.

Permanent Secretary—L. O. Howard, Smithsonian Institution, Washington, D. C.

General Secretary—Frederic E. Clements, University of Minnesota, Minneapolis, Minn.

Secretary of the Council—John Zeleny, University of Minnesota, Minneapolis, Minn.

Secretaries of the Sections:

A—Mathematics and Astronomy—George A. Miller, University of Illinois, Urbana, Ill.

B—Physics—A. D. Cole, Ohio State University, Columbus, Ohio.

C—Chemistry—C. H. Herty, University of North Carolina, Chapel Hill, N. C.

D—Mechanical Science and Engineering—G. W. Bissell, Michigan Agricultural College, East Lansing, Mich.

E—Geology and Geography—F. P. Gulliver, Norwich, Conn.

F—Zoology—Maurice A. Bigelow, Columbia University, New York, N. Y.

G—Botany—H. C. Cowles, University of Chicago, Chicago, Ill.

H—Anthropology and Psychology—George Grant MacCurdy, Yale University, New Haven, Conn.

I—Social and Economic Science—Fred. C. Croxton, 1229 Girard Street, Washington, D. C.

K—Physiology and Experimental Medicine—George T. Kemp, Hotel Beardsley, Champaign, Ill.

L—Education—Charles Riborg Mann, University of Chicago, Chicago, Ill.

Treasurer—R. S. Woodward, Carnegie Institution, Washington, D. C.

SCIENTIFIC NOTES AND NEWS

THE Nichols gold medal of the American Chemical Society for the year 1909–10 has been awarded to Professor M. A. Rosanoff, of Clark University, and his pupil, Mr. C. W. Easley, for their joint study of the partial vapor pressures of binary mixtures. The formal award will take place at the meeting of the New York Section on January 6, 1911.

DR. ADOLF VON BAEYER, of Munich, has celebrated his seventy-fifth birthday.

THE Bolyai prize of 10,000 Kronen of the Hungarian Academy of Sciences has been awarded to Dr. David Hilbert, of the University of Göttingen.

PROFESSOR F. W. WOLL, chemist of the College of Agriculture of the University of Wisconsin, was elected president of the Association of Official Agricultural Chemists of America at the recent annual meeting in Washington, D. C.

THE Earl of Stair has been elected president of the Royal Scottish Geographical Society in succession to Professor James Geikie, F.R.S., who has held the office of president for the last six years. The anniversary meeting of the society was held on November 11, and was addressed by Sir John Murray on "The Deep Sea."

DR. OTTO HÖNIGSCHMID, of Prague, who last winter carried out at Harvard University an exact revision of the atomic weight of calcium under the direction of Professor T. W. Richards, has now begun a study of the atomic weight of radium at the new Radium Institute in Vienna.

THE council and fellows of the Chemical Society, London, honored five of their past-presidents who had completed their jubilee as fellows by entertaining them at a banquet at the Savoy Hotel on Friday, November 11. We learn from *Nature* that a large gathering, numbering 250, including the presidents of the French and German Chemical Societies and eleven past-presidents, was presided over by Professor Harold B. Dixon, F.R.S., the president. The names of the past-presidents who were being honored were:

	Elected	President
Professor William Odling, F.R.S. .	1848	1873–5
The Rt. Hon. Sir Henry E. Roscoe, F.R.S.	1855	1880–2
Sir William Crookes, O.M., F.R.S.	1857	1887–9
Dr. Hugo Müller, F.R.S.	1859	1885–7
Dr. A. G. Vernon Harcourt, F.R.S.	1859	1895–7

The president referred to the personalities of the jubilee past-presidents, and to the particular work in which each was more especially distinguished: Sir Henry Roscoe, for his research on vanadium and as a pioneer educationist; Sir William Crookes, for his discovery of thallium, his researches on the rare earths, the genesis of matter and diamonds, and his brilliant discoveries in physics; Dr. Hugo Müller, for his researches on cellulose and discoveries in connection with printing; Dr. Vernon Harcourt, for his researches on the rate of chemical change and his work as an enthusiastic teacher; and Professor William Odling, the doyen of chemistry, to whom all chemists will find it difficult to fathom their debt of gratitude. Unfortunately, Sir Henry Roscoe was absent through illness, and his address was read by the president. Addresses were made by the other past-presidents.

MME. CURIE is a candidate for the *fauteuil* at the Academy of Sciences, rendered vacant by the death of M. Gernez.

AT the quarterly meeting of the board of trustees of the American Museum of Natural History held on November 14 the following changes were made in the scientific staff: Dr. Louis Hussakof was appointed associate curator of fossil fishes; Mr. John T. Nichols, assistant curator of recent fishes, and Dr. William K. Gregory, assistant in the department of vertebrate paleontology.

Mr. O. W. Barrett, until recently director of the Department of Agriculture of Mozambique, has accepted the position of chief of division of experiment stations, U. S. Department of Agriculture, at Manila. He has already reached his new post.

Mr. Barnum Brown, of the department of vertebrate paleontology of the American Museum of Natural History, has recently returned from an expedition to Montana which completes the work on the Laramie formation begun in 1902 and carried on continuously since that time except during the year 1907. The most important specimen obtained was an unusually complete skeleton of *Trachodon*.

Professor Herschel C. Parker, of the department of physics of Columbia University, accompanied by Mr. Gilmore Brown and other members of last summer's expedition, will make a third attempt this winter to reach the summit of Mount McKinley.

On November 11 and 12, Professor Edmund B. Wilson, of Columbia University, delivered two lectures before the University of Missouri under the auspices of the Society of the Sigma Xi. The subjects of the lectures were "Some Latter Day Aspects of Heredity and Evolution" and "Heredity and the Chromosomes."

Dr. John Dewey, professor of philosophy at Columbia University, will lecture at the University of Pennsylvania, under the Harrison Foundation, on "The Problem of Truth." The subjects and dates of the lectures are as follows: December 6, "Why Truth is a Philosophical Problem"; December 8, "Correspondence, Coherence and Consequence as Marks of Truth"; December 9, "Truth as Objective." Following Dr. Dewey's lectures, Professor Josiah Royce, of Harvard University, will deliver three lectures on "Truth" on February 6, 7 and 8.

On December 3, Dr. George Grant MacCurdy, of Yale University, lectured at the University of Pennsylvania, his subject being "The Antiquity of Man in Europe." This was the first of a series of lectures to be given by various speakers on "The History of Mankind."

Dr. Georg Kerschensteiner, of Munich, Bavaria, delivered an address on the trade schools of Munich at the University of Chicago on November 14. Dr. Kerschensteiner is a member of the Royal Council of Education of Bavaria and superintendent of the public schools of Munich. He has come to America at the invitation of the Commercial Club of Chicago, which is making a study of the advantages of industrial education and which has sent Edwin G. Cooley, former superintendent of the public schools of Chicago and a graduate of the University of Chicago, to Europe to investigate trade schools.

"The Inefficiency of Natural Selection" was the subject of Profesor H. H. Lane's presidential address before the Oklahoma Academy of Science at its second annual meeting held in November. The address will probably be printed in full by the state university. Dr. D. W. Ohern was elected president of the academy at its recent meeting.

A memorial has been erected at the National Bacteriological Institute in the City of Mexico to Howard T. Ricketts, who at the time of his death was assistant professor of pathology in the University of Chicago and professor-elect of pathology in the University of Pennsylvania. His death was caused by typhus fever, which he contracted while conducting researches in this disease.

Dr. Christian Archibald Herter, professor of pharmacology and therapeutics in the College of Physicians and Surgeons of Columbia University, died on December 5 at the age of forty-six years.

Dr. Angelo Mosso, professor of physiology in the University of Turin and a member of the Italian Senate, died on November 24 at the age of sixty-four years.

The Association of the Alumni of the College of Physicians and Surgeons offer the Cartwright prize, $500, open to universal competition, for the best essay on any medical, surgical or kindred subject. The essays must contain the original work of the author and must be submitted on or before April 1, 1911. In the spring of 1912, the alumni prize of

the same value will be offered, open only to the alumni. These prizes are biennial and alternate annually. They are supported by funds in the hands of the Association of the Alumni and are to be given in perpetuity.

THE next meeting of the Association of American Universities will be held at the University of Chicago in November, 1911.

THE officers of Section D of the American Association have sent a notice to the members and others interested stating that the rapid advance in the navigation of the air during the past year has attracted serious attention to scientific aeronautics. The construction of dirigible balloons and flying machines is essentially a mechanical problem and as such merits consideration by Section D, especially since no engineering society has yet taken this action. Accordingly at the Minneapolis meeting, December 27–31, 1910, papers are invited relating to aerodynamics and other branches of aeronautics, and also discussing possible course of instruction in colleges and technical schools. Attention is also directed to the fact that some papers on the science of road building and related topics have been promised, and that others are desired to complete the program for a session of the section devoted to this subject.

THE third annual meeting of the Association of Official Seed Analysts was held at the Shoreham, Washington, D. C., on November 14 and 15. The following papers were presented:

Some Germination Studies of Seeds of Forage Plants—Dr. L. H. Pammel, Miss Charlotte M. King and Mr. H. S. Coe.

Germination Studies of the Seeds of the Umbelliferæ—Mr. Geo. T. Harrington.

Agricultural Value of Hard Seeds in Alfalfa and Clover—Professor H. L. Bolley.

Notes on the Morphology of Hard Seeds—Mr. Geo. T. Harrington.

The Essentials of Agricultural Seed Analysis—Mr. F. H. Hillman.

Seed Conditions in Indiana—Professor G. I. Christie.

At the business session a constitution was adopted and the following officers were elected:

President—Dr. E. H. Jenkins, of Connecticut.

Vice-president—Dr. L. H. Pammel, of Iowa.

Secretary—Mr. E. Brown, of Washington, D. C.

Additional members of the Executive Committee—Professor H. L. Bolley, of North Dakota, and Professor W. H. Barre, of South Carolina.

The president appointed the following committee and referees:

Committee on Seed Legislation—Dr. C. D. Woods, of Maine, chairman, and Dr. L. H. Pammel, of Iowa.

Referees: Sampling—Dr. C. D. Woods, of Maine. Purity—Professor H. Garman, of Kentucky. Germination—Mr. E. Brown, of Washington, D. C.

UNIVERSITY AND EDUCATIONAL NEWS

TRINITY COLLEGE, in Durham, N. C., will receive from Mr. Benjamin N. Duke, four new buildings which are designed to form a quadrangle on the campus. The Duke family has now given the institution almost a million and a half dollars.

CONCRETE foundations for the new horticultural building at the University of Wisconsin, which is to cost $60,000, are completed, and the work on the structure will be pushed as rapidly as weather conditions will permit. The new building will comprise a basement, two floors and an attic, and will furnish offices, class rooms and laboratories for the horticultural and plant pathology departments. It is to be a fire-proof structure of brick, trimmed in stone, with a tile roof.

THE collections of the chemical department of the University of Wisconsin, which have been recently brought together to form a museum in the corridors of the chemistry building, now include thirteen different departments of chemistry and its related branches.

THE officers of the department of physics of the University of Illinois gave a reception on Saturday evening, November 19, to the faculty of the university and their friends in the physics building. The building was in normal working condition and the instructors and students in the department were on hand to show visitors through the building and to explain apparatus and methods. The guest of honor was Professor Albert A. Michelson, of

the University of Chicago, president of the American Association for the Advancement of Science.

DISCUSSION AND CORRESPONDENCE

THE EFFECTS OF PARASITIC CASTRATION IN INSECTS

In his very interesting paper on the above subject published in the *Journal of Experimental Zoology*, for July, 1910, Professor W. M. Wheeler says (p. 419) that "Giard has given good reasons for supposing" that the dimorphism exhibited by the forcipes of male earwigs from the Farne Islands, Northumberland,[1] is due to "differences in the number of gregarines they harbor in their alimentary tract." The reference to Giard is *Comptes Rendus Acad. Sci.*, 1894, Vol. 118, p. 872.

> J'ai tout lieu de croire qu'une interprétation du même genre (referring to the changes brought about in *Carcinus* by the action of parasites) peut s'appliquer pour la distribution des longueurs des pinces des Forficules mâles. Il est possible, en effet, d'après la longueur de la pince, de prévoir qu'une Forficule mâle possède des Grégarines et qu'elle en possède une plus ou moins grande quantité.

We do not, however, feel justified in regarding this passage alone (and there is no further account by the French observer) as direct evidence that Giard had examined the intestine of *Forficula* for gregarines and found a correspondence between their presence and the differing states of the male secondary sexual characters. In this connection we may record our own observations made to resolve this debatable point. In 1907 we visited the Farne Islands and collected several thousand earwigs. Over fifty dimorphic males were carefully dissected and a large gregarine (presumably *Gregarina ovata*) was found to occur commonly in the alimentary canal. Examples were, however, contained indifferently in low males as well as high; in both they were sometimes absent and no correlation could be observed between the number of parasites in an individual and the length of its forceps. It may at the same time be mentioned that no difference in the development of the testes or other internal sexual organs could be detected in high and low males respectively.

[1] Bateson and Brindley, *Proc. Zool. Soc. London*, 1892, p. 585.

H. H. Brindley
F. A. Potts

Zoological Laboratory,
University of Cambridge,
October 20, 1910

MONO- AND DI-BASIC PHOSPHATES

Recently my attention has been directed to the confusion in the use of the terms "mono-" and "dibasic" as applied to the alkali salts of orthophosphoric acid. As certain authors make use of these terms without further qualification, it seems desirable to call attention to the conflicting use of these terms and to urge instead the use of more precise designations.

Orthophosphoric acid, H_3PO_4, is generally considered to be a tribasic acid. As salts of this acid, it seems only logical to call KH_2PO_4 dibasic, and K_2HPO_4 monobasic. In Merck's and some other catalogues, KH_2PO_4 is called monobasic, and K_2HPO_4 dibasic. These firms commonly send out their preparations labeled as follows: "Potassium phosphate—Dibasic," and "Potassium phosphate—Monobasic."

No further explanation appears on the label, and unless one happens to consult the catalogue (and this does not always explain) one is apt to get curious results in the use of these salts. The more serious difficulty appears, however, in the use—without other qualification—of the terms "mono-" and "di-basic phosphate" in literature. This is frequently the case in physiological and bacteriological papers. In discussion of the matter with a number of technical chemists it was evident that the conflicting use of these terms was not confined to biologists.

In view of the confusion resulting from the uncertain use of the terms "mono-" and "di-basic" as applied to the alkali phosphates, I would urge all workers—and chemical supply houses—to discontinue the use of these terms and to substitute more exact terms, such as primary, secondary and tertiary, respectively, for the salts KH_2PO_4, K_2HPO_4, K_3PO_4. It

would be even clearer, perhaps, to speak of these salts as mono-, di- and tri- *potassium* phosphates. In all cases it is desirable to give the formula as well as the name of the salt.

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THE LOAN OF LANTERN SLIDES TO ILLUSTRATE LECTURES ON HOOKWORM DISEASE

REQUESTS for the loan of lantern slides to illustrate the anatomy and life history of the hookworm and the methods of preventing hookworm diseases have increased to such an extent that I have ordered several extra sets of forty-five slides each.

These slides will be loaned to medical societies, colleges, schools, teachers' associations, women's clubs, etc., that may desire to use them. The two conditions attached to the loan are: (1) that all requests be forwarded through the secretary of the state board of health; (2) that the slides be returned, express prepaid, immediately following their use.

Preference will be shown to societies and institutions in hookworm-infected states.

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SCIENTIFIC BOOKS

Die Variabilität niederer Organismen. Eine deszendenztheoretische Studie von HANS PRINGSHEIM. Berlin, Julius Springer. Pp. 216.

Dr. Pringsheim has done a unique and valuable piece of work in thus resuming our knowledge of unicellular organisms from the standpoint of the student of variation, heredity and evolution. The book is based mainly on bacteriological work, together with work on yeasts and pathogenic protozoa. This is probably just, since it is chiefly in these groups that investigation has gone deep enough to furnish data on the problems of genetics. Other groups of protista are not left out of consideration, and a number of the more important pieces of work on these are dealt with, but the pertinent literature is by no means so fully considered as in the case of the groups mentioned. The author is himself an investigator in bacteriological lines, and has gone over the literature in this and related fields with a fine-toothed comb, bringing forth whatever bears on the problems of genetics. This material is well digested and is arranged in unified sections following a well-laid-out plan. The references to literature are so extensive as to make this a handbook of the subject.

There is an introduction dealing with variation and inheritance in a general way. This is followed by sections on the struggle for existence in lower organisms (with many concrete examples, of great interest); on the normal "breadth of variability"; on variation in form and structure; in colonial growth; in movements and reactions; in spore-formation; in production of ferments and of colors; in virulence; variation as evidenced in acclimatization to heat and cold; to light; to variations in food and oxygen, to poisons, etc. A final chapter gives some general results, with suggestions for future work.

A broad view is taken of all these phenomena, so that the author gives us what might be called a general (though condensed and concrete) treatise on the physiology of protista, dealt with from the standpoint of genetics. From the purely physiological point of view the result serves as a valuable corrective for the impressions obtained from physiological works that deal chiefly or only with the supposedly typical.

The author is very conservative as to the conclusions to be drawn regarding fundamental problems, though this does not conceal the enthusiasm which he feels for his subject, particularly for its future. He holds that it has been proved that in certain cases fluctuating variations have shown themselves heritable, giving rise to new races; and that in some cases direct adaptations have proved heritable—concrete cases being cited for each.

In the great majority of cases, however, neither of these categories of change give heritable results. There are many other points of extreme interest to students of genetics; the chapter on variation and regulation in the production of ferments, for example, will be found specially suggestive, since here we appear to be dealing with one of the elemental phenomena of life, and a study of the genetic relations of these things is hardly possible in higher organisms. The author, however, rightly characterizes his book as chiefly a program for future work. A well-known authority on bacteriology expressed to the reviewer his belief that results of great importance for the theory of genetics, such as the appearance of new heritable characteristics by adaptive change, can not be accepted with confidence from the study of bacteria, owing to the extreme difficulty of isolation, and the impossibility of following and identifying individuals and their progeny. Apparently the author of the present work is not so convinced that this difficulty is insuperable, and it has apparently been overcome in certain cases, as in the work of Barber. But a certain weakness in the positive conclusions to be drawn is here indicated, though this makes the book all the more inspiring to the man with the investigator's spirit, since it suggests to him many lines of work that can be carried out on the higher protista, where individuals can readily be followed and positively certain results reached. To all such, as well as to the general student of evolutionary problems, this book will be found of much value.

H. S. Jennings

The Coleoptera or Beetles of Indiana. By W. S. Blatchley. Bulletin No. 1, Indiana Department of Geology and Natural Resources. 8vo, pp. 1,386, 590 figs. Indianapolis, 1910.

This volume is the first in America to deal with our native coleoptera in a comprehensive manner. There has been no single work to which one could resort for the determination of beetles, and this condition has compelled many to abandon the study of this important group of insects. The present work will, therefore, in a measure, supply a long-felt want; for, while ostensibly it treats only of the species found in Indiana, the majority of them are so widely distributed that it will be a most valuable aid in the determination of coleoptera from the eastern United States and Canada.

In this bulky volume all the Coleoptera, excepting the Rhynchophora, are treated. The familiar classification of LeConte and Horn is adhered to and accordingly the forms treated are divided into six series. There are identification tables for the families, tribes, genera and species. There are 2,535 species recorded as actually occurring in the state and 777 others which have been found in adjoining territory are added, and all these are included in the identification tables. Those known from the state are furthermore described and notes given on their regional and seasonal occurrence, and habits when known. A number of new species, scattered through the larger families, and one new genus are described. The new genus, *Blanchardia,* is placed in the Omethini, a tribe of problematic position but here referred to the Telephorinæ. The name *Blanchardia* has already been proposed for no less than four different genera; *Blatchleya* is proposed as a substitute for the present one. There are a goodly number of figures, not a few of them original, the remainder taken from all available sources. At the end is a glossary of technical terms, an index to the families and genera, and finally an index to the species described as new. Attention must be called to the fact that this last is not complete. There are omitted the species published under the manuscript names of others and described here for the first time and, therefore, to be credited to Professor Blatchley. Also the newly described varietal forms, for which trinomials are employed, should have been included in this index as some of them may, on further study, be raised to specific rank. It is possible that some of the forms described as new in the Staphili-

nidæ will interfere with those published recently by Colonel Thos. L. Casey.[1] The names of Blatchley will, however, have priority, as his report was issued September 20 (received at the U. S. National Museum September 23), while Colonel Casey's paper has the date of issue September 24, 1910.

The task which Professor Blatchley set himself and carried to a finish is gigantic and one is filled with admiration for the energy, perseverance and enthusiasm which alone could have carried it through. Any one at all familiar with the multiplicity of forms in the Coleoptera, and the extensiveness of the literature, will realize the labor involved. In this case it must have been very materially augmented by the fact that Professor Blatchley lives remote from large libraries, collections and fellow-workers.

That there are shortcomings and errors in a work of such scope, carried out single-handed, must be expected. Some of these are due to the fact that the author has had to depend for the most part on the current American entomological literature. Thus *Smilia* in the Coccinellidæ is preoccupied and replaced by *Microweisea* Cockerell. Gahan has shown that in the cerambycid genus *Cyllene* the names *robiniæ* and *pictus* both apply to the same species and for the form occurring on the hickory the name *caryæ* was proposed. Systematically the work reflects closely the present state of North American coleopterology. While there has been great activity in the description of new species and genera the broader study has been practically neglected since the days of LeConte and Horn; no attempt has been made by our students to follow the progress of the science abroad. Thus the position of the Rhyssodidæ in the adephagous series has long been an established fact. The grouping of the families has, for good reasons, been very much modified in recent years and the conception of certain families has entirely changed.

Perhaps the greatest weakness of the work is on the biological side, and this too indicates the backward state of our knowledge on this side of the Atlantic. There are many statements concerning habits and larval characters which need correction. The Clavicornia are broadly stated to be scavengers, whereas, in fact (and in accordance with the heterogeneous character of the group as here considered) their habits are most diversified. In the Silphidæ both the genera *Necrophorus* and *Silpha* are said to bury dead animals, but this is only true of the first-named genus. Some mention should also have been made of the habits of the smaller forms which are now generally considered to belong to two separate families, the Liodidæ (Anisotomidæ) and the Clambidæ. Of the Staphylinidæ the broad statement is made that "they feed upon decaying animal and vegetable substances." This is probably true of but a small part of this large group, as many widely separated forms have been shown to be predaceous both as imagos and larvæ. A very loose statement concerning staphylinid larvæ is that they, "except in the absence of wings, resemble the adults both in structure and habits." Under the elaterid genus *Melanactes* the old error with reference to the luminous female and larva (the two being identical in structure) of *Phengodes* is perpetuated, and this in spite of the fact, as appears from the text, that Mr. Henshaw advised the author of the true relation of these forms. Many of the original figures, while fairly faithful in detail, are not characteristic and give a wrong impression of the habitus of the insects. This can not be wondered at when one considers the difficulty of securing competent talent for such work. In this respect the unexcelled figures from the reports of Forbes, which are reproduced, are in striking contrast.

In the introductory part of the work Professor Blatchley tells us that the Rhynchophora are not included on account of lack of time and space, but the hope is held out that a future report will be devoted to them. We understand that Professor Blatchley not only has the necessary collections at hand but that he also has the manu-

[1] "Memoirs on the Coleoptera," I.

script partly prepared. It is therefore to be hoped that this part will soon follow and thus the entire order of Coleoptera be covered.

The edition was limited to one thousand copies and, we understand, is practically exhausted. It is to be hoped that a revised edition, in generally available form, will soon be forthcoming. With the general demand for a work of this character there should be an extensive sale for the work for many years to come.

Frederick Knab

Leitfaden der experimentellen Psychopathologie. Von Adalbert Gregor. Pp. 222. Berlin, S. Karger. 1910. M. 6.80.

In this book the author attempts to give, in a series of sixteen lectures, the applications of the methods of experimental psychology to the study of mental diseases. Considering the limited amount of literature of experimental psychopathology, and the still more limited extent of its established fact, it would appear a difficult task to produce a book of such scope with strict adherence to its subject, nor is it accomplished save through the inclusion of much detailed analytical discussion. The single topics are treated quite distinctly in the successive lectures, and in another edition it will be well if page and chapter headings are provided for the text and bibliography. A very critical introductory chapter is followed by another of equal merit on the time sense, of which the author has himself made some pathological studies. The chapter on reaction time is also well constructed, but these three lectures set a standard that is scarcely reached elsewhere in the book, save perhaps in the seventh and eighth, on memory, and in the fourteenth, on the involuntary expressive movements. The chapters on association give only the merest elements of the question at issue, and the two chapters on *Aussage* might well have been condensed. One might, as a psychopathologist, also criticize the sense of proportion that gives two indifferent chapters to *Aufmerksamkeit* and but one to voluntary movement—practically confined to discussion of the ergograph and the *Schriftwage*. The questions of the work-curve in the higher mental processes are discussed in the fifteenth lecture, while the last deals with measures of intelligence—without a mention, even bibliographical, of Binet and Simon.

The seven pages of bibliography are nevertheless useful, for while they omit a good deal that the psychologist would ordinarily know of, as Hoch's pathological work with the ergograph, the studies of Kramer and of Wolfskehl on memory, and of Vogt or Alechsieff on feeling, it contains a good many titles of importance not apt to be familiar to the worker whose horizon does not extend well beyond the literature of normal psychology; examples are the too little known studies of Ranschburg on memory, and the various papers of Gregor himself.

In a general treatise, equal merit throughout could be achieved only by an equal lack of it, and the author has probably done what he tried to do as well as any single writer on the hither side of Kraepelin could have done it. And yet the book suffers from an underlying fault in conception that to the psychopathologist will go far indeed to outweigh all its virtues. It is the last weakness that one would expect in a physician, accustomed to clinical contact with actual cases. The book seeks not only to translate the methods of normal psychology into pathological terms, but also its problems. Now normal psychology has its well-defined problems, as the reader of this journal knows them, but it recks little of such pressing questions of psychopathology as the experimental criterion of confusion, the distinction between retardation and blocking, or the differential psychology of hallucinosis. To the psychological reader, the volume would scarcely give a hint that such questions existed. It is a doubtful service to explain how various methods of normal psychology, adapted to its own special problems, can be tried on pathological cases, too. It were a very real service to discuss the various psychotic symptoms in their appropriate clinical settings, and to explain the application of psychological methods to their further elucidation. Here the book fails grievously; and one can not but

regret that this opportunity should have been so lightly passed over by a writer with every appearance of unusual fitness to improve it.

FREDERIC LYMAN WELLS

SCIENTIFIC JOURNALS AND ARTICLES

The Internationale Revue der Gesamten Hydrobiologie und Hydrographie published at Leipzig with an editorial board consisting of Dr. Bjorn Helland-Hansen (Bergen), Professor George Karsten (Halle), Professor Charles A. Kofoid (Berkeley), Professor Albrecht Penck (Berlin), Dr. Carl Wesenberg-Lund (Copenhagen), Professor Friedrich Zschokke (Basel) with Professor R. Woltereck (Leipzig) as editor-in-chief, has with the beginning of volume 3 enlarged its scope and modified the form of its publication. In addition to the *Revue* proper, which will be issued in six parts per year forming an annual volume of 600 pages, there will be also biological and hydrographical supplements, forming annual volumes of 300 pages each, a Jahresbericht of literature in the hydrobiological and hydrographical fields, of about 300 pages, and a quarto series of monographs. The *Revue* proper will contain shorter original articles, critical summary of special fields of investigation, reviews of pertinent literature from various countries and of important works, news items regarding biological stations, expeditions, university instruction in the field of the *Revue,* etc. The supplement volumes will contain the more extensive papers with plates and the monograph series, the still larger reports of expeditions, lake surveys, etc., and the more extensive biological memoirs. Contributions for the journal and papers for review may be sent to the American editor, Professor Charles A. Kofoid, Berkeley, California, or directly to the Editor-in-Chief.

SPECIAL ARTICLES

THE SARGASSO SEA

SOMEWHAT more than fifty years ago, Maury[1] announced that midway in the Atlantic, in a triangular space between the Azores, Canaries and Cape Verde islands, the sargasso sea embraces an area equalling the Mississippi Valley in extent and so thickly covered with gulf weed that the speed of vessels is often impeded. To the eye at a little distance it seems substantial enough to walk on. His map represents the area of weed as shaped like an hourglass, with the broader space toward the west. It extends from 19° to 66° west longitude, the eastern portion from 17° to 30° and the western from 22° to 28° north latitude.

A few years later, Ansted[2] said that a considerable space between 20° and 40° west longitude and 15° to 30° north latitude is sometimes so matted with brownish weed as to hide the water, resembling a drowned meadow on which one can walk. It holds trees and plants from the Mississippi and Amazon.

Thomson[3] does not define the limits of the sargasso sea, but places the northern border near the Azores. He seems to think that it extends to south from the Bermudas. The floating islands of gulf weed are usually from a couple of feet to two or three yards in diameter, but he saw on one or two occasions fields several acres in extent; and he thinks that such expanses are probably more frequent near the center of the area of distribution. They consist of a single layer of feathery bunches of *Sargassum bacciferum,* not matted but floating nearly free of each other, only enough entangled for the mass to keep together.

Carpenter[4] limited the area more closely, for he says that the sargasso sea is comparatively still water between 30° and 60° west longitude and 20° and 35° north latitude, into which is gathered a considerable portion of the drift or wreck of the north Atlantic.

[1] M. F. Maury, "Physical Geography of the Sea," new edition, New York, 1856, pp. 30, pl. vi.

[2] D. F. Ansted, "Physical Geography," 2d ed., Philadelphia, 1867, p. 148.

[3] C. Wyville Thomson, "The Atlantic," New York, 1878, II., pp. 15, 16, 24.

[4] W. B. Carpenter, "Encyclopedia Brittanica," 1887, III., p. 20.

The indefinite descriptions of the area and mass of seaweed, as well as the extraordinary statements made by some authors in discussing the origin of coal, induced the writer to make an examination of the conditions for himself. The matter is easy, because the steamship route between Barbadoes and the Azores crosses the area diagonally and passes very near the center. In going from Barbadoes to the Azores the steamer crossed—

North latitude	21° 8′	at 50° 17′	west longitude.
	24° 39′	46° 2′	
	27° 44′	41° 36′	
	30° 53′	36° 57′	
	33° 58′	31° 57′	

In returning from the Azores to Barbadoes the crossings were

North latitude	21° 46′	at 48° 18′	west longitude.
	24° 59′	44° 4′	
	28° 3′	39° 57′	
	31° 8′	35° 28′	

The return course being approximately two degrees east from the outward route. On the twenty-seventh parallel the line is very near the center of the usually accepted area as defined by Carpenter. Returning, the steamer passed by daylight much of the area passed by night on the outward passage.

On the outward passage, the first seaweed was seen just north from the twenty-first parallel, but only a few isolated bunches, 6 to 12 inches in diameter. As the twenty-third parallel was approached, weed became more abundant and the quantity increased until nightfall, when the twenty-fifth was crossed. The bunches, all well isolated, were from 5 to 18 inches in diameter and occasionally they occurred in lines 50 or more feet long. During much of the day, the number of bunches averaged about a score to the acre and frequently there were spaces 1,000 feet wide, without any trace of weed. On the twenty-sixth parallel, the weed was comparatively abundant, but it was still in separated bunches, though one patch was observed about 6 feet square. The arrangement ordinarily is linear, following the direction of the wind, approximately northeast and southwest; sometimes there is a long line of single bunches while at others there are strips 3 to 10 feet wide; but the intervening spaces of 100 to 500 feet are almost weedless. On the twenty-seventh parallel, the ship was in west longitude 41° 36′, therefore almost central in the sargasso, but there the weed had practically disappeared. Occasionally a short line was seen but the ship many times passed 1,000 feet with no trace. Beyond the twenty-eighth parallel the number of bunches averaged about 25 per hour, while beyond the thirty-first one sees only an occasional fragment.

On the return voyage, seaweed seemed to be absent until the twenty-eighth parallel was reached at west longitude 40°, where a few bunches were seen. No more was observed until the twenty-third parallel at west longitude 45°, where some lines of single bunches were crossed. Beyond that not more than 30 bunches, all told, were seen until Trinidad was reached.

During the voyage from Barbadoes to the Azores, the writer had opportunity to gain important information from two officers who had crossed the sargasso sea many times. Captain W. J. Dagnall, of the R. M. S. P. steamship *Orotava* was long in charge of a steamer plying between Jamaica and Southampton, a route much farther west than between Barbadoes and the Azores, as it crosses the twenty-seventh parallel 750 miles away, but thence the routes converge. Along this western line the seaweed is often abundant, but neither there nor on the Barbadoes-Azores route did he ever see a patch of weed exceeding an acre in extent. Much depends on the time of year, for weed appears to accumulate while the trades are mild and to be broken up later in the season when the strength of the winds increases. In any case, however, the weed occupies only a small part of the area, the patches being separated by wide spaces of clear water, almost free from weed. Many of the bunches show unmistakably that they had been attached to rock; and the plants have traveled far, since in a large

proportion of bunches only a part is living, the dead parts being of a brownish color.

Captain Dagnall's statements were confirmed by Captain George Morrison of the R. M. S. P. steamship *Berbice,* who had been in charge of steamers between Jamaica and Southampton as well as of a steamer plying between Jamaica and the Canaries. But he thinks that patches of weed one acre in extent are very rare, and he was unwilling to assert that he had ever seen one larger than half an acre. In his opinion the gulf weed is torn off from the Bahamas by the waves and the greater part of it is swung around those islands. The writer's own observations agree with this, for in passing through the Bahama archipelago along the seventy-fourth meridian, he found the seaweed much more abundant than along either of the lines followed across the sargasso. The weed is evidently the same, being in circular bunches up to 18 inches diameter arranged in strips according with the direction of the wind, though occasionally in bands or even in patches 8 by 10 feet. The patches are near the large islands.

Seaweed occurs abundantly off the coast of Venezuela. It comes from the borders of the Orinoco delta and it was seen on the return voyage at about west longitude 62°. Thence it was very abundant to near the sixty-sixth meridian, where it disappeared abruptly and no more was seen except a small area near the seventy-second. The abrupt disappearance is difficult to explain; it is not due to decay, for the last exhibition was of apparently fresh weed; the distance from the source is too small to justify the supposition of decay, for the gulf weed is still living after having traveled from the Bahamas round to the east side of the sargasso. This is not the gulf weed, to which it bears no resemblance.

At best, the quantity of weed seen at any locality is wholly insignificant. Midway in the sargasso sea, the bunches seen in a width of a mile would form, if brought into contact, a strip not more than 65 feet wide. This, where the weed is most abundant. But the bunches are very loose, the plant material, as was estimated, occupying less than one fifth of the space, so that if the bunches were brought together so that the plant parts would be in contact, each square mile would yield a strip not more than 13 feet wide and 3 or 4 inches thick, or barely 2,500 cubic yards of uncompressed seaweed to the square mile. In most of the area traversed, the quantity would be but a small fraction of 2,500 cubic yards to the square mile—and the conditions are the same along the lines described by Captains Dagnall and Morrison. The accumulation of decayed vegetable material from seaweeds must be comparatively unimportant under the sargasso sea; and what there is would be merely foreign matter in mineral deposits.

The trade winds are comparatively gentle in early July, and the latter part of August, when the writer made the voyages; but they are sufficient to raise waves of five to eight feet and the sea is covered with "white caps." Later in the season the winds become much stronger. Reasoning *a priori,* one can hardly conceive it possible that, with the water in constant motion, the floating débris could accumulate *en masse* over any considerable area; even should such accumulation take place during a period of comparative quiet so as to protect the water from wind, it would soon be broken up by wave attacks along the borders; for the patches of weeds are not matted like peat—they are merely agglomerations of loose bunches drifted together.

JOHN J. STEVENSON

IS THERE DETERMINATE VARIATION?

UNDER this title I published in SCIENCE four years ago[1] a paper discussing the changes from year to year in the color pattern of the beetle *Diabrotica soror* as these changes had been observed by me during the decade 1895–1905. The observations depended on the collection each year (1896–1900 omitted) at approximately the same time and place (in the later years two separate places each year) of series of 1,000 individuals, and the determination and tabulation of the color-pattern

[1] Vol. XXIV., pp. 621–628, November, 1906.

conditions. A progressive change from one condition to another was noted and the question was asked if this change were not an example of determinate variation. The other possible explanations, *i. e.*, natural selection and temporary ontogenic modification, were considered and held to be inapplicable.

I have continued the annual inspection of the color pattern status of the beetle since 1905 and present in the following notes the results of the observations of the last five years (1905–10). In order to make reference to the earlier paper unnecessary to hurried readers I résumé in this the data of the 1895–1905 observations and repeat two or three paragraphs of explanation.

The beetle *Diabrotica soror* is a chrysomelid species that infests our California flower gardens.

In its larval stage this beetle lives as a slender white grub underground, feeding on the roots of alfalfa, chrysanthemum and various other plants. It pupates in a small subterranean cell near the surface and the adult beetle, on issuance from the pupal cuticle, makes its way above ground and feeds on the buds and open flowers of roses, chrysanthemums and almost any other of California's favorite blossoms. The color pattern of the adult is, of course (as the insect is one of "complete metamorphosis"), definitive and fixed as to both pattern and color at the time of the first appearance of the adult above ground.

This beetle has its black and green colors arranged on its back (dorsal surfaces of the wing-covers) in the form of twelve distinct black blotches or spots on a green ground, six spots in three transverse pairs (or two longitudinal rows) on each wing-cover. At least the original description of this species gives this patterning, and systematic accounts and revisions of the genus have always ascribed to the species *soror* twelve separate black blotches on a green (or yellow-green) ground. In Horn's revision of the genus in 1893[2] the fact of a tendency of the black spots to coalesce is fleetingly referred to. But undoubtedly the twelve-free spots type is the pattern which is accepted as the typical and usual one.

[2] *Trans. Amer. Ent. Soc.*, V., 20, p. 89 ff.

The pattern variation is shown (by selecting certain principal types appreciably distinct) in Fig. 1, where *A* represents the condition accepted by the systematists as typical of the species (both right and left elytra are shown); *B* shows the two spots of the middle transverse pair of the left wing-cover fused;

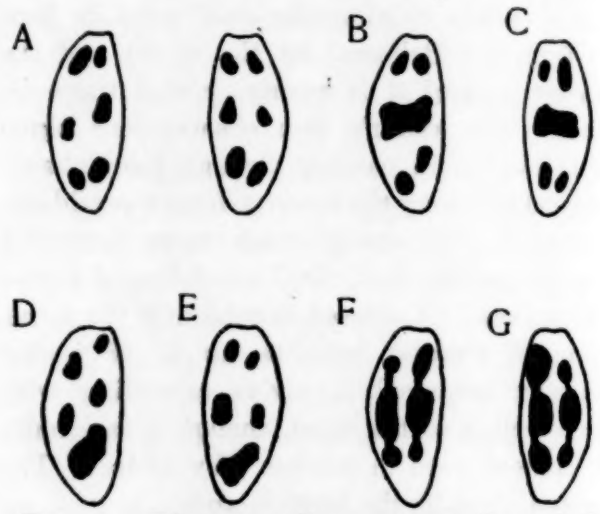

FIG. 1. Diagrammatic representation of the varying elytral color pattern of the California flower beetle, *Diabrotica soror*. (The ground color is green; the spots are black.)

C, the corresponding two spots of the right wing-cover fused; *D*, the two spots of the posterior transverse pair of the left wing-cover fused; *E*, the corresponding spots of the right wing-cover fused; *F*, the longitudinal fusing of the spots on the left wing-cover, and *G*, the corresponding condition for the right wing-cover.

These different patterns are closely connected by intergrading conditions; that is, there may be (theoretically) and are (actually) all degrees of fusion of the two spots in these various pairs that show fusion at all, from the slightest running together to the more pronounced cases shown by the diagram. But for the sake of aggregating individuals into describable groups any fusion is called fusion, and the existence of even the slightest space or line of green between two spots is recognized as "no fusion" or "free

spots." As a matter of fact, in the great majority (about five sixths) of cases of fusion the spots are well joined.

In the following tabulation of condition of the varying color pattern in the species (on the Stanford University campus) in different years, series of approximately 1,000 are used. That a series of 1,000 individuals collected from one locality at one time fairly represents, in the variation revealed by its wise noted were collected on flowers in approximately the same place on the campus. All the lots were collected in October.

The following tabulation gives the data for all the series examined since 1895.

That the relative frequencies of the principal two pattern conditions may be more readily obvious I present in the following table the percentages of these types for each of the lots studied.

Year (Oct.)	Number of Individuals in Lot	All Spots Free	Middle Spots of both Elytra Fused	Middle Spots of Left Elytron Fused	Middle Spots of Right Elytron Fused	Miscellaneous[1]	Notes
1895	905	383	203	55	64	200	On campus flowers.
1901	905	313	396	32	60	104	On campus flowers.
1902	905	313	388	40	55	109	On campus flowers.
1902	405	228	105	12	18	42	This lot was collected at Santa Rosa, Cal., sixty miles north of the Stanford campus.
1904	1,546	442	832	41	63	168	On campus flowers.
1905	1,000	352	465	43	52	88	On campus flowers.
1905	1,120	301	604	56	73	86	This lot was collected on *Baccharis* about two miles from the collecting ground for the other lots.
1905	1,005	491	306	43	57	108	This lot was collected at San Jose, Cal., twenty miles south of the Stanford campus.
1906	516	181	215	27	27	66	On campus flowers.
1907	786	282	344	32	55	51	This lot was collected on *Baccharis*.
1908	413	162	127	30	36	58	On campus flowers.
1908	594	319	127	31	38	79	This lot was collected on the *Baccharis*.
1909	1,128	485	393	61	69	60	On campus flowers.
1909	999	358	417	64	60	100	This lot was collected on the *Baccharis*.
1910	953	449	303	33	55	113	On campus flowers.
1910	1,093	458	363	48	67	157	This lot was collected on the *Baccharis*.

members, the actual variation conditions of the species in this locality, as regard both kinds of variation and frequency of these kinds, is proved by repeated tests made by examining and tabulating successive thousands taken at random from the same place at the same time and finding a practical identity in these separate lots. Indeed, series of 500 gave practically approximately the same proportions as those of 1,000. But the larger number is the safer. All the lots not other-

[1] Lateral fusion of anterior or posterior spots; longitudinal fusions, etc.; always includes some cases of lateral fusion of middle spots accompanying fusions.

Years	All spots free	Middle spots fused
1895	42.35	22.40
1901	34.05	43.70
1902	34.04	42.80
1902 (Santa Rosa)	56.29	25.92
1904	20.90	65.40
1905	35.20	46.50
1905 (Baccharis)	26.87	53.92
1905 (San Jose)	48.85	30.45
1906	35.08	39.73
1907 (Baccharis)	35.88	43.76
1908	39.20	30.75
1908 (Baccharis)	53.70	21.38
1909	43.00	34.93
1909 (Baccharis)	35.83	41.74
1910	47.11	31.80
1910 (Baccharis)	41.90	33.21

From the preceding tables it will be seen that the statement in my earlier paper (1906) based on the data for 1895–1905 was true. But this statement can not be repeated for the series 1906–10. The statement made in 1906 is:

> If series of 1,000 really reveal the variation conditions of the color pattern in the species in these different years (and our check lots show that they do) it is apparent from these statistics that *Diabrotica soror*, in this particular locality, has in ten years changed from a form in which one pattern type was the mode to one in which another is the mode. And this change has been gradual and cumulative; not made by a mutation or by discontinuous variation, *i. e.*, discontinuous evolution. The two modes or predominant types of pattern are connected to-day as they were ten years ago by all degrees of gradations; the variation, that is, is typically continuous or "Darwinian" in type.

Since 1906 this change from all-spots-free to middle-spots-fused has not proceeded nor even maintained itself. In 1908, 1909 and 1910 the lots studied from the campus flowers have all shown a predominance of the all-spots-free type. That is, the mode has swung back to the 1895 condition, or we may say, the species type. In the light of this fact, and in the suggestive light of the conditions presented by the lots taken from the Baccharis two miles away from the campus flowers and by the lots taken at Santa Rosa and San Jose in 1902 and 1906, it seems obvious that my case of determinate variation resolves itself into a case of fluctuational variation determined in one direction, then in another, in some way by a probably varying environment (using the word in a broad sense to include varying temperature, humidity, food supply, etc., during larval and pupal life of the beetles). There is no indication just what influence it is during immature life that is modifying the imaginal color pattern in this very definite and wholly unadaptive way, but some such influence must be behind the variation. It is certainly no inherent modifying principle working toward a purposeful or even purposeless goal, because it does not work consistently. And yet it is no such simple modification of a total color tone by low temperature or high humidity as I have been able to produce experimentally in certain insects of incomplete metamorphosis, *e. g.*, *Murgantia histrionica*, the harlequin cabbage bug. It is a variation determined in certain alternating directions by a changing environment, by extrinsic influences working non-adaptively and unreasonably—may I say?—that is, producing changes that are not such as our knowledge—lamentably incomplete, to be sure—of the relation of varying food, temperature, humidity, light intensity, etc., to insect colors, enables us to prophesy.

The beetle still presents to me, therefore, an enduring interest even if it be not behaving in the way suggested by my questioning use in 1906 of the phrase "determinate variation."

Vernon L. Kellogg
Stanford University, Cal.

Societies and Academies

The Biological Society of Washington

The 474th regular meeting of the society was held in the hall of the Cosmos Club on November 12, 1910, with President T. S. Palmer in the chair and a good attendance of members.

Under the heading "brief notes," Dr. Barton W. Evermann reported continued success in keeping the two fur seals from the Pribilof Islands, which were received at the Bureau of Fisheries last spring. He reported also that ten more seals had been brought from the north on the revenue cutter *Bear* and landed safely at Seattle. Of these seven are now feeding well and the other three less satisfactorily. It is intended to distribute the ten as follows: two to Golden Gate Park, San Francisco; two to the New York Aquarium; four to the National Zoological Park, Washington, D. C.; and two will be left at Seattle, if suitable accommodations for them can be provided.

The following communications were presented:

A New Jaguar Record for Texas: Vernon Bailey.

The present record is of a large specimen of the jaguar killed last spring in central Texas, near London, Kimble County, not far from the Llano River. Mr. Bailey showed a lantern slide photograph of the dead animal and also a map showing localities of the principal records for this animal within the United States. The jaguar formerly

ranged over the greater part of the territory south of the Red River, but for many years was regarded as extinct throughout the interior of Texas.

Forage Plant Investigations in Mexico: A. S. HITCHCOCK.

During the summer of 1910, Mr. Hitchcock, systematic agrostologist of the U. S. Department of Agriculture, was engaged in studying and collecting the grasses of Mexico and southern Texas. Except for about three weeks spent at San Antonio, Corpus Christi, Brownsville and Sarita, Texas, the time was spent in the republic of Mexico. All the states north of the Isthmus of Tehuantepec were visited, except Sonora (visited previously by the speaker), Sinaloa and the Territory of Tepic. Collections were made at the following places: Monterey, Saltillo, San Luis Potosi, Cardenas, Tampico, Querétero, various localities in the Federal District, Popo Park, Mt. Popocatepetl, Oaxaca, Tomellin, Tehuacán, Esperanza, Chalchicomula, Mt. Orizaba, City of Orizaba, Córdoba, Vera Cruz, Jalapa, San Marcos, Pachuca, Balsas, Cuernavaca, Toluca, Acámbaro, Uruápan, Manzanillo, Colima, Zapotlán, Nevada Peak, Guadalajara, Irapuato, Aguas Calientes, Zacatecas, Torreón, Durango, Chihuahua, Sanchez and Miñuca.

Mr. Hitchcock was accompanied by his son, Frank H. Hitchcock, as assistant, with whose help he was enabled to collect about 20,000 specimens of grasses, of 2,703 numbers. An effort was made to visit the type localities, especially of the earlier collectors. In this way several species were found, which because of insufficient information, have been considered doubtful. Other species supposed to be rare or local were found to extend over a wide range. It appears to be a fact, however, that many species are much more localized than is commonly the case in the United States. The interior of Mexico consists of a plateau, mostly 5,000 to 8,000 feet in altitude, with mountain ranges of higher elevation, the snow-capped peaks of Orizaba and Popocatepetl rising to the height of about 17,500 feet. The northern part of the plateau is arid, the annual rainfall being less than 10 inches. The precipitation increases toward the south and in the Sierra Madre Mountains, and reaches a maximum of over 80 inches in the southern part of the state of Vera Cruz. The rainy season usually extends through July, August and September.

The grasses of the plateau region are smaller than those of southern Arizona, many species being common to both. *Muhlenbergia, Stipa* and *Bouteloua* are dominant genera. Along the eastern coast is a strip of lowland, 50 to 100 miles wide, in which the grasses are poorly represented. It is at the juncture of the plateau and the lowland that the grasses are found in greatest profusion. From 1,000 to 4,000 feet altitude, along the sides of the *barancas* (steep and deep valleys, or cañons) occur numerous species of *Panicum, Paspalum* and other interesting tropical genera.

Of the localities visited, Cardenas, Jalapa, Orizaba and Cordoba are situated on the eastern slope of the plateau, and Colima and Zapotlán on the western slope. At the last two places the genus *Tripsacum* is especially noticeable, certain species closely resembling in habit our cultivated Indian corn, or maize.

Pear Thrips Investigations in California: A. L. QUAINTANCE.

Mr. Quaintance detailed the present status of the investigations by the Bureau of Entomology of the so-called pear thrips (*Euthrips pyri* Daniel) in California, illustrating his remarks with lantern slides. It was stated that the insect is now generally present in the deciduous fruit growing areas of Santa Clara, Contra Costa, Alameda and Solano counties, with points of serious infestation in Sacramento, Yolo, Napa and Sonoma counties. According to estimates prepared by Messrs. S. W. Foster and P. R. Jones, the bureau's agents in immediate charge of the work, the losses to the fruit growing industry from this insect to date totalled about $3,500,000, with probabilities for an annual loss, due to its continued spread and increase in destructiveness of one million dollars.

Much progress was reported in control measures. It had been determined that in the lighter soils a great deal of good may be accomplished by deep plowing and cross plowing of orchards in the fall, at which time the insect is in the helpless pupal condition and easily destroyed. In the Santa Clara Valley careful records extending over two seasons have shown that about 70 per cent. of the insects may be killed in this way. In other types of soil in which the insects are able to penetrate deeper, in some instances to a depth of 24 to 28 inches, but little benefit was found to result from this work.

It was pointed out that decidedly a most effective method of control of pear thrips was thorough spraying of trees with a combined dis-

tillate oil and nicotine spray in the spring just as the buds were swelling and before the bud scales had separated sufficiently to allow the entrance of the minute insects. A thorough drenching application of trees at this time, followed by a second treatment just before the blossoms opened, resulted in the destruction of a very high percentage of the insects in orchards and insured ordinarily a good crop of fruit. However, in case where these two sprayings were not properly accomplished, a treatment against the larvæ after the falling of the blossoms was advised, thus protecting the foliage from injury and preventing scabbing of prunes, which in the absence of treatment is often extremely prevalent, greatly lowering the grade of the product.

Full confidence was expressed in the outcome of the work now in progress, but one of the greatest difficulties experienced was stated to be necessary cooperation of individual growers in some sections.

The first communication was discussed by several members.

D. E. Lantz,
Recording Secretary

The Anthropological Society of Washington

The 449th regular meeting of the society was held in the hall of the Public Library, November 15, 1910, 8 P.M., with the president, Dr. J. W. Fewkes, in the chair.

The first paper of the evening was on "New England Life in Old Almanacs," by Mr. George R. Stetson. The earliest almanac extant from New England is dated 1645. The almanac literature forms quite an extensive library. In the Astor Library there are recorded about 2,000 titles. Besides the calendarium proper, the almanacs contain information and give advice on all the relations and conditions of life. Much attention is given in them to the movements of the celestial bodies and their phenomena, especially to comets. In fact, the old almanacs, like many of their later successors, were small cyclopedias, and thus shed much instructive and interesting light on the life of the times in all its relations and phases.

Dr. Ales Hrdlicka followed with an account of the exploration of "An Ancient Sepulcher at San Juan Teotihuacan, with Anthropological Notes on the Teotihuacan People." San Juan, which is about forty miles distant from the City of Mexico, was the sacred city of what was perhaps the first civilized race that inhabited Mexico. The site is marked by two stepped pyramids, called the "pyramid of the sun" and the "pyramid of the moon" respectively. They are faced by a court of monuments, which are assumed to have been temples, called the "street of the dead." The grave opened by Dr. Hrdlicka was situated about 250 yards southeast of the E.S.E. corner of the pyramid of the sun. In this grave, which was shielded by two cement floors (aside from layers of earth and rubble), were found two skeletons, one of a man about forty-five years of age, the other of a woman of over fifty years of age, buried in the classic contracted fetus-in-utero position. Both bodies must have been interred simultaneously, for there was no displacement of any of the bones. They lay parallel, with head to the east. Near the skeletons were found earthenware dishes, fragments of mother-of-pearl rings, beautiful obsidian knives of the long, slightly curved, flake variety, a shell disk and a bowl provided with three short legs. The bones show no traces of disease or any injuries in life, but both the crania are artificially deformed; this is specially true of the female. The deformation is of the fronto-occipital variety. But the deformation is not so great as to prevent the recognition of the original type of the crania—they were both brachycephalic. The stature of the two individuals, as far as can be judged from the bones, was rather above medium, as compared with that of the present native population in the valley, and the same may be said of the strength of the bones.

Dr. Hrdlicka called attention to the following points of interest connected with the find: (1) the peculiar construction of the grave; (2) the fact that here were buried together an adult man and an adult woman suggests a sacrifice of the woman on the occasion of the death of her husband; (3) here is for the first time found what looks as clear evidence that the artificial head-deformation of the flathead type was actually practised by at least a part of the ancient inhabitants of these regions, and (4) it is evident that the ancient builders of Teotihuacan, or at least an important part of them, were of the brachycephalic type.

The two skeletons, as well as the objects found with them, are deposited at the San Juan Museum.

The paper was discussed by Messrs. Lamb, Fewkes, Hewitt and Gronberger.

J. M. Casanowicz,
Secretary